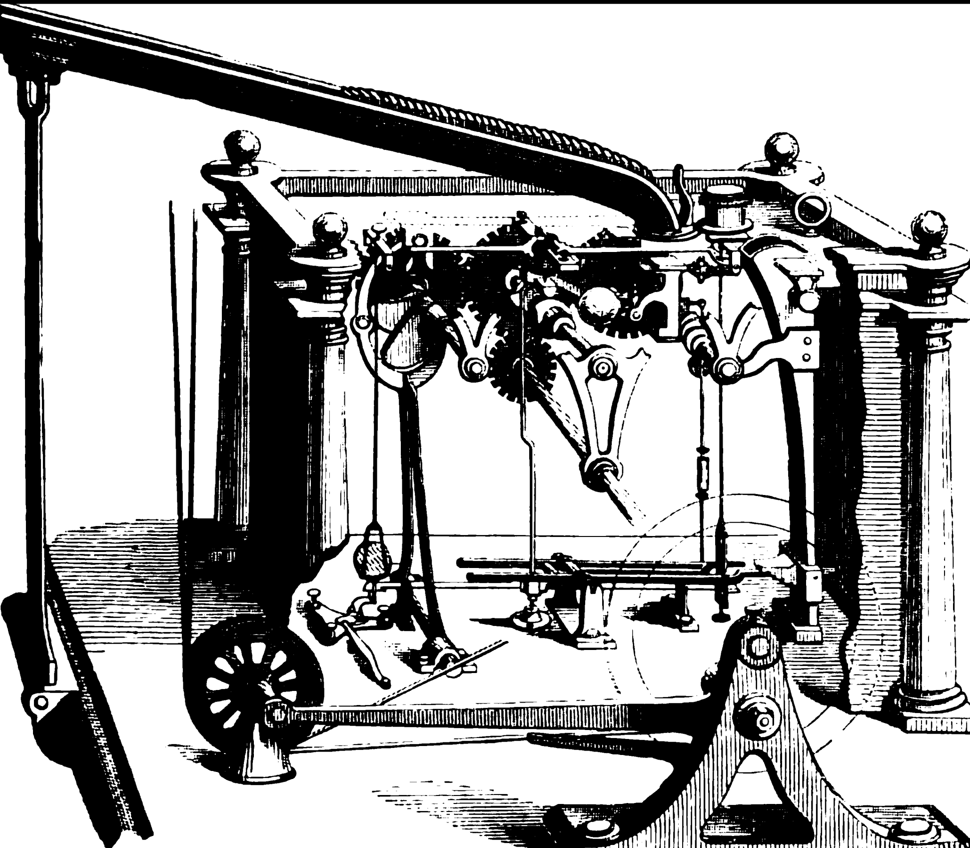


The Intellectual Observer

1. Sparassis crispa. 2. Rhizina undulata.

—1566—

THE

·LLECTUAL O·S·

L· VIEW OF NATURAL HI·

·ROSCOPIC R·

AND

RECR· ·TIVE

·ATED W·

ENGRAV·

LONDON

G· OOMB·IDGE A·D SO·S,

P·TERNOSTER ROW

·D ·CLXIV.

-1500-

THE

INTELLECTUAL OBSERVER:

REVIEW OF NATURAL HISTORY,

MICROSCOPIC RESEARCH,

AND

RECREATIVE SCIENCE.

VOLUME V.

ILLUSTRATED WITH PLATES IN COLOURS AND TINTS, AND NUMEROUS ENGRAVINGS ON WOOD.

LONDON:
GROOMBRIDGE AND SONS,
PATERNOSTER ROW.

MDCCCLXIV.

HARRILD, PRINTER, LONDON.

ILLUSTRATIONS.

ILLUSTRATIONS IN COLOURS.

TINTED PLATES.

ENGRAVINGS ON WOOD.

CONTENTS.

THE INTELLECTUAL OBSERVER.

FEBRUARY, 1864.

A NEW BRITISH FUNGUS.

BY THE REV. M. J. BERKELEY, M.A., F.L.S.

(*With a Coloured Plate.*)

THOUGH so much has been done since the conclusion of the Cryptogamic part of the English Flora in 1837 towards forming a perfect list of British Fungi, the experience of the present abnormal season shows that there still remains much to reward diligent research. Not only has Mr. Broome, amongst other novelties, added to our list almost all the curious and beautiful species of Ascobolus described by the Messrs. Crouan, of Brest—a dung-borne genus distinguished by the curious property of partially ejecting the little sausage-like sacs, or asci, which contain the sporidia—while Wales and Scotland have made some welcome additions to our list; but the Rev. G. H. Sawyer has shown that many of the nobler forms which adorn the pine forests of the Continent may still be expected to occur in the more southern districts. In company with *Hydnum imbricatum,* one of the most striking of British fungi, though a rare inhabitant of our fir woods, he finds an equally large species, *Hydnum lævigatum,* together with the beautifully tinted *Hydnum tomentosum, and H. zonatum,* of which the two former are new to this country; and, in addition to these, *Rhizina undulata,* equally novel and remarkable for its fine fruit, of which, together with the plant itself, we give a sketch. But, besides these objects of interest, and others which we refrain from enumerating, he has contributed to our Fungology the genus *Sparassis,* a genus so striking that Fries declares that *Sparassis crispa,* the species which has occurred near Maidenhead, is the most beautiful of all the fungi he has ever seen. Without pledging our taste quite so far, we consider the object so beautiful, in addition to its

superior esculent qualities, that it seems worthy of an especial notice in the INTELLECTUAL OBSERVER.

Most of our readers are acquainted with the little tufts of white, cylindrical bodies, which occur in profusion on our close-shaved lawns in autumn, looking like little bundles of wax tapers. They belong to *Clavaria vermicularis,* one of the simplest forms of the genus *Clavaria,* which contains a large number of esculent species, amongst which the little candles, though small, are not to be despised when dressed in little faggots, like bundles of asparagus. Other species of the genus are simple and club-shaped, others branched, and some to such a degree that they look like little shrubs divested of their leaves. Some are even, and some much wrinkled; and, though a few are slightly compressed, they never assume the form of foliaceous expansions, though a neighbouring genus, once confounded with it, but distinguished by its more leathery consistence, departs from the cylindrical type. They exhibit the most various hues, as white, golden yellow, rose, amethyst, grey, orange, with many intermediate tints.

The genus, *Sparassis,* the name of which is derived from *σπαράττω,* "I tear or lacerate," with the fleshy consistence of *Clavaria* and similar esculent characters, has flattened laminæ, which are in every part covered with the fructifying surface, or hymenium. In *Thelephora* and the closely allied genus, *Stereum,* in which the divisions are often much flattened and expanded, there is not only a leathery consistence, but the hymenium is definite, being confined to the lower surface.

In *Sparassis* the lobes are extremely large and numerous, so as to form a rounded and sometimes hemispherical mass, occasionally a foot or more in diameter, with a height of several inches; which, together with a delicate waxy appearance, render the species most striking objects. The habit is somewhat similar to that of *Millepora reticulata,* an analogy which is not without example amongst other Lithophytes; in which, as Fries remarks, we find forms which remind us of such genera as *Agaricus, Boletus, Hydnum, Clavaria, Peziza,* etc. Similar resemblances occur amongst the galls on leaves produced by insects, which accordingly have been confounded by superficial observers, even since the principles of Fungology have been better known, with true fungi.

Sparassis laminosa, which may be considered as the type of the genus, has not yet occurred in this country. It is found on old oak stumps, or amongst oak chips, and acquires the size of a large cauliflower. When pure in colour and young it is excellent, but it soon acquires a yellow tinge and disagreeable smell, and is then wholly unfit for food. The laminæ are very

large and broad, springing from a very short stem, and are narrow and wedge-shaped below, but dilated above, and confluent with each other in every direction.

Sparassis crispa, though sometimes attaining a considerable size, is on a smaller scale. The laminæ are more rounded and leaf-like, though curled, and folded, and variously lobed and laciniate, with a crest-like margin, and springing from a well-marked, thick, rooting stem, the greater part of which is sunk in the soil. The hymenium is more or less uneven, and rather wrinkled, or rough, with little wart-like elevations. In decay the margin becomes soft, acquiring first a yellow, then a brownish tinge, and finally the whole forms a loathsome mass. Like all other esculent fungi, those specimens only are fit for use in which there is not the slightest tendency to decay.

Sparassis crispa, which was found in a fir wood in south-east Berkshire, between the Asylum for Criminals and the Wellington College, where there is much fern and heath, occurs in several parts of Europe. It is rare in Sweden, but more common in Germany, especially about Prag, where it is frequently brought for sale to the market. It also occurs in France in the provinces bordering on the Rhine, where it is said by Roques to be highly valued. We have not heard of its being used in Hungary, nor does it occur in a large collection of fungi gathered in the neighbourhood of Schemnitz.

It is scarcely probable that it will be found in this country in sufficient quantities to make it an article of food, but in case it should be found plentiful, we subjoin Roques' "*indications*" for its preparation, which apply equally to true species of *Clavaria,* to which genus, indeed, it is referred by Roques, in this following Wulfen, who described it in *Jacquin's Miscellanea Austriaca.* Schæffer referred it previously to *Elvella,* with a less correct appreciation of its affinities.

"The plant," says Monsieur Roques, "should be well cleaned from any particles of soil which may adhere to it, then washed in warm water and thoroughly drained, after which it should be baked with butter, parsley, a little eschallot, or a soupçon of garlic, and seasoned with pepper and salt. When tender, cream and yelks of eggs should be added. While baking, a few spoonfuls of stock or broth may be added occasionally, to make it more tender. In Austria it is simply fried in butter, and seasoned with sweet basil.

OBSERVATIONS ON THE THREE-SPINED STICKLE-BACK—ITS OVA AND FRY.

GASTEROSTEUS ACULEATUS.—Linnæus and Bloch.
GASTEROSTEUS SPINULOSUS.—Yarrell, Br. F. vol. i.

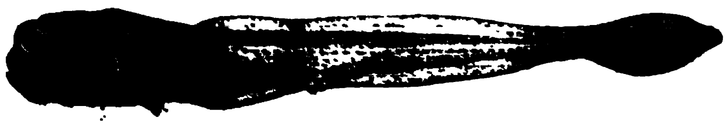
BY J. H. HORSFALL.

(*With an Illustration.*)

THE taste for aquaria may not be so fashionable as it was some time ago, but the taste for pisciculture is at *fever heat,* and I know of no object more interesting to the microscopist than the ova and fry of fish.

Those who may not be able to procure fecundated ova of salmon or trout, may yet derive as much amusement and instruction by examining the ova of inferior fish, and by studying its development be able to follow the scientific lecturer in his description of the ova and fry of the more valuable kinds.

I am induced to make these remarks from having, on the 3rd of June last, found several nests of the three-spined stickleback in a small brook near Leeds, which, after leaving Adel Dam, runs through the village of Meanwood, at which place it receives the refuse of some large tanneries, in which polluted water the nests appeared to be as abundant as in the purer water nearer the source of the brook.



THREE-SPINED STICKLEBACK, EIGHT DAYS OLD.

NATURAL SIZE.

The nests were about four or five yards apart, and guarding each nest was a male stickleback, and it was easy to see at a glance which fish was the master tyrant of the colony, his colours being much brighter and more vivid than the others in his immediate vicinity could show; the back a rich green, growing darker towards the tail; inside the lower jaw, and along the gill covers and belly, a vivid red; the eye deep blue, with a rich deep black pupil, the fins appearing nearly transparent.

I secured the most brilliant-coloured male fish I could find, and the nest he was guarding; it was full of ova, in which

could be seen plainly the eyes of the embryo fry. On reaching home, however, I found the colour of the fish much duller, and the green on the back had changed to a dusky blue.

In Mr. Couch's *History of the Fishes of the British Islands*, vol. i. p. 167,* is a most interesting account of the habits of this fish, especially its pugnacious disposition. For this reason I placed in the same vessel with the nest and the male fish three females. At once the male began a furious attack on the trio, chasing them about, seizing the most weakly by the tail, dragging it half round the vessel, rising with it to the surface of the water, as if to force it out; sometimes he would seize it by the pectoral fin, and turn it violently on its side, continuing these attacks incessantly, until, in twelve hours, the weakest female died; the next died in about six hours after the first. During these attacks the females acted only on the defensive, by projecting the ventral spines, and could they have received him on the sharp point of one of these weapons, such was the force with which he swam at the female, that death to the tyrant must have immediately followed. The male was very bold; he would follow the feather with which I removed the newly-hatched fry, and if the fry escaped off the feather, he seized his infant fish, and devoured it at once. From the first dead female I abstracted some immature ova, which he pounced upon the moment I placed them in the water; then he blew out a portion, re-caught it as it descended, and again ejected a portion to renew his attack on the second dying female. When resting from his attacks on the other fish, he invariably hovered with his nose close to the hole of the nest, with tail considerably elevated, and blew a strong current of water through the nest by means of his pectoral fins.

The nest is curiously formed, but not of such minute particles as those described in Mr. Couch's account. One piece of withered grass measured seven inches, and was so interwoven with the rest as to drag the whole nest some distance before I could extricate it. To save the life of the surviving female, I put her into a separate vessel, and as soon as the male found himself alone he swam round the nest several times, forming it into shape by the rapid action of his pectoral fins; at short intervals he plunged his nose into the opening as if to clear it, and resumed his position, hovering over the nest, and forcing water in a strong current through it. His dorsal spines were now laid back so as to be hardly visible; when, however, he was attacking the females these spines were constantly erect. He often took the empty crusts of the hatched ova, as well as the

* *A History of the Fishes of the British Islands.* By Jonathan Couch, Esq., F.L.S. London: *Groombridge and Sons.*

fry that had died in the hatching, into his mouth, but instantly ejected them.

The fry began to hatch out the day I got the nest; three ova hatched while under examination with the microscope. First I saw distinctly the entire fish curled up in the shell of the ovum; a convulsive movement, and the tail protruded, and, by a continuance of these convulsions, the entire fish freed itself from the crust of the ovum in about twenty-five minutes after the crust was first ruptured; in some instances the head and tail protruded simultaneously, in which case the crust of the ovum remained round the fry like an awkward belt, which was not got rid of under forty-eight hours.

The newly-hatched fry is a quarter of an inch long, and is furnished with a transparent membrane, like the fry of salmon and trout. This membrane commences where the anterior dorsal fin in the adult fish is seen, and continues unbroken till it reaches a short way over the umbilical vesicle, where it terminates. Inside this membrane, forming the outline of the fish itself, a very fine dark brown line extends all round the fish, and inside this a faint double streak of a pale orange colour. These orange lines are blood-vessels, and, with a high power, the blood-discs can be clearly seen running from and to the heart, which is situated just under the lower jaw, its colour light red, its beat rapid, the mouth of the fish opening with every pulsation of the heart; the eyes as well as the head are large, the latter covered with several irregular dark brown spots. On the day after hatching, the fish assumes much more colour, losing its transparency, so that the flow of blood in the body is not so clearly seen; but in the umbilical vesicle, which is becoming rapidly absorbed, the flow of blood in its numerous vessels is very visible. The incessant motion of the pectoral fins suggests the fluttering of a phantom, they are so transparent.

On the third day after hatching, the fry is much more covered, especially on the head, with dark brown spots, having deeply serrated edges; some of these spots also appear on the umbilical vesicle. Through this colour the heart is no longer visible, nor any blood-vessels, except those between the rays of the pectoral fins, which are losing their transparency, and are at times for a moment stationary. The eyes as well as the head occasionally move, the mouth continually opens and shuts; the outer circle of the eye can be perceived through the microscope. The fry now are very active, often swimming to the surface of the water, then sinking gradually to the bottom, when, after a short rest, they dart rapidly about again.

On the fourth, fifth, and sixth day after hatching, my infant sticklebacks make little progress; the umbilical vesicle is gra-

dually being absorbed, the spots on the body show less serrated edges, and are deeper in colour; the entire surface of the fish is stained rather than coloured a cinnamon brown; the enveloping membrane is much reduced in places, especially at what will form the root of the caudal fin.

On the seventh day the rays of the anal fin begin to appear, six imperfect rays of a brown colour being visible under the microscope; the lower jaw alone maintains its transparency. On the eighth day, the markings of the anal fin are more perfect, the membrane is much narrower, except where the spines and fins in the adult fish are seen; four days after this, or on the twelfth day, the first formation of the caudal fin is seen, also the protrusion of the ventral spines.

Notwithstanding a daily change of water, on the thirteenth day my infant sticklebacks were attacked by a parasite, invisible to the naked eye, but, when magnified, it was adhering to the membrane which still encircled the fish. This membrane showed clearly the ravages of the invader, being torn in several places, and by this I lost my whole stock, losing first their activity and in twelve hours, life.

It was my intention to have ascertained how long after fecundation the ova remain before the fry are hatched, and the different periods that elapse in the development of the dorsal and ventral spines, and also the dorsal, caudal, and anal fins; this I am obliged to defer to another season. I have, however, seen enough to prove that the delightful study of pisciculture may be successfully followed without practising on the ova of valuable fish like the salmon and trout, for quite sufficient resemblance exists between the development of the ova and fry of the insignificant sticklebacks and the king of fresh-water fishes, that he who studies the inferior may easily understand the greater.

THE MOSSES ANACALYPTA AND POTTIA.

BY M. G. CAMPBELL.

February, with its chilling breezes, its sleety storms, its leafless trees, and its oft snowy lawns, while it seems to freeze the young buds of the tall trees, and hang their boughs with icicles, yet spares the lowly mosses, and gives some of the most minute and delicate strength to ripen their tiny fruits.

Of these, the genus Anacalypta stands foremost, deriving its name from *ἄνα, above*, and *καλυπτὸς, covered*, in allusion to the circumstance that the calyptra remains on the capsule until the spores are perfectly ripe, which is, doubtless, a provision of nature against the inclemency of the season.

The members of this, like those of its sub-genus *Pottia*, named in honour of Professor Pott, of Brunswick, are small, chiefly annual or biennial mosses, loosely gregarious, growing upon newly-exposed soil, and occasionally upon walls in low-land districts. The two sections are exceedingly similar in mode of growth, in fruit, in the form and structure of the leaves, and in the inflorescence; but differ in the Pottias being without a peristome, while the Anacalyptas proper are furnished with a peristome, which consists of a single row of sixteen teeth, united at the base by a narrow membrane, plane, lanceo-late or imperfectly divided into two portions, or perforated; occasionally, however, incomplete or fragmentary, and without a medial line. The spores, too, are rather smaller than in Pottia.

On banks and in fields in the middle and south of Britain, those who wish to investigate this interesting group may find the beautiful little *Anacalypta Starkeana*, (*Stark's Anacalypta*), of which we give a magnified illustration; the natural size of the plant being less than one line in height of stem, and, when in fruit, with a seta of about equal length; but in this, as in other respects, the species is variable, for in the same tuft may be found specimens with fruit-stalks twice as long as others. It will, however, admirably serve as a type of both sections of this genus; indeed, it has puzzled muscologists to determine to which section it should properly be given, the presence or absence of a peris-tome being the chief difference between it and *Pottia minutula*, or the *dwarf Pottia*, variety *conica*, which might almost be called a toothless *Anacalypta Starkeana;* and, if we may judge by the variety of names that have been conferred upon it, as A. Starkeana by Nees and Hornshuch, Bruch and Schimper;

ANACALYPTA STARKEANA.

Pottia Starkeana, by C. Müller; Grimmia Starkeana, by Smith and others; Bryum minutum, by Dickson; and Weissia affinis by Hooker and Taylor; while Wilson confesses that he "dare not pronounce them" (the two mosses, *Anacalypta Starkeana* and *Pottia minutula*) "distinct, having examined numberless intermediate forms, which pass insensibly from the one to the other." We shall, perhaps, be ready to exclaim, "Who shall decide where doctors disagree?"* Yet we conceive that, if gathered during the present month, before there is a chance of the peristome being lost, which may be more fugatious than hitherto suspected; and if due attention be paid to the position of the foliage, that of *P. minutula* being more erect and appressed to the stem in a dry state, in all the specimens we have examined, as well as having the lower leaves frequently of a reddish hue, there may be less difficulty in deciding on its proper name and location.

Having thus shown that the peculiar form of the fruit and foliage is sufficiently characteristic of the whole family, genus, and sub-genus, we now proceed to describe *Anacalypta Starkeana* more particularly.

As we have already said, its length of stem is less than one twelfth of an inch, within which stature it bears two kinds of leaves, the lower ones less, of an ovate acuminate form; the upper ones larger, oblong acuminate, or lanceolate, carinato-concave, the margin recurved, the reddish nerve excurrent, and forming a short mucro at the apex of the leaf, very seldom discontinued below it, all of them spreading; the areolæ small and roundish, like the perforations of a very fine pin or needle point, larger at the base, the capsule oval, with rather thin walls of a shining chestnut-brown, sometimes regularly striped with lines of a deeper tint; the lid conical and obtuse; annulus persistent; teeth of the peristome usually of a pale red or yellow colour, lanceolate, and obtuse, with distant transverse bars, but very variable, both in form and colour, more or less perforated, without a medial line, and erect when dry; the fruit-stalk loosely cellular, almost semi-pellucid, usually straight when growing, slightly curved in a dry state, and somewhat twisted; the spores smoothish, the barren flowers axilliary, mostly leafless, sometimes, but rarely, with a single involveral leaf; while the *Pottia minutula*, which in other respects it so nearly resembles, has barren flowers of from two to three leaved. Both are found in fruit during January and February, but the Pottia appears to continue in fructification longer than the Anacalypta.

* It must, however, be acknowledged that there are few mosses which have not been honoured with a like multiplicity of names, a circumstance, doubtless, chiefly arising from the advance of science rendering the old nomenclature defective, from incorrectness or inadequacy.

There are three other Anacalyptas, all of which fruit in the spring. Of these, *A. cæspitosa,* or the *Round-fruited,* grows on chalk hills, and has been found on Woolsonbury Hill, near Hurstpierpoint, Sussex. It is about the same size as *A. Starkeana,* but is easily distinguished from it by the rostrate lid of the capsule, which latter is also more ovate, and of a yellowish-brown, with a yellowish fruit-stalk, and plane-margined and narrower foliage. *A. cæspitosa* has also a distinct perichætium, the inner perichætial leaf being very broad and sheathing, and a yellowish annulus surrounds the mouth of the capsule. It fruits in March, as does also *Anacalypta lanceolata,* or the *Lance-leaved Anacalypta.* The latter is, however, of taller stature, the stems being from one line to half an inch long. The oval capsule, tapering at the base into a rather long reddish pedicel, has rather thick walls, of a glossy chestnut colour, and is somewhat contracted below the mouth when dry. The lid is obliquely rostrate, but varies in length, sometimes longer, sometimes shorter; the simple annulus dehiscing in fragments; and the peristome in this, as in Starkeana, is extremely variable; sometimes the teeth are almost linear, and rather long; sometimes shorter, and lanceolate obtuse; sometimes linear lanceolate, and rather acute, formed of a double row of cellules, here and there perforated along the medial line; somewhat jointed, flattish and minutely papillose, *i. e.,* rough, with small roundish prominences, and usually of a pale reddish-fawn colour; sometimes of a deeper red; sub-erect when dry, or slightly incurved at the apex; somewhat oblique in direction, and always connected below by a common membrane. The yellowish-brown calyptra reaches half-way down the capsule.

The rare *Anacalypta latifolia* also fruits in the spring, but it can never be confounded with either of the others; its singularly bulb-like clustered foliage, of an almost silvery hue, gives it so peculiar an aspect as at once to distinguish it. The leaves are roundish-ovate, apiculate, or obtuse, very concave and imbricated, not recurved in the margin, membranous, shining, and whitish, with an erect capsule, whose lid is half as long as itself, and bearing a calyptra that reaches half-way down the capsule; the seta long, and annulus sub-persistent. It is an elegant moss, inhabiting alpine districts, where it is found in the crevices of rocks. It is met with in several places in Switzerland, and has been found on the Clova mountains in Scotland, in Glen Phee or Glen Dole, by Mr. Drummond.

Of the Pottias, *P. cavifolia,* or the *oval-leaved Pottia,* is remarkable for the variation in the length of its leaves, fruit-stalk, and capsule, even when growing in the same locality; the different forms growing in patches, not promiscuously, but

in separate groups; some having fruit-stalks more than half an inch long, others with the seta scarcely a line in height, and with leaves equally diverse, so that one unacquainted with the circumstance might easily imagine them to belong to different species. It may, however, always be known by the peculiarity of three or four membranous appendages attached to the nerve on the upper side of the leaf. These appendages are analogous to the lamellæ of *Polytrichum hercynicum* and the allied species.

The leaves are, besides, erecto-patent, concave, slightly imbricated, obovate, or elliptical, and more or less piliferous; sometimes, however, they are destitute of the hairy point. The capsule is oval, crowning a shorter or longer pedicel, and having an obliquely rostrate lid shorter than the capsule. It is found on banks and mud-walls, and bears its fruit in March.

Pottia truncata, or the *common Pottia*, ripens its fruit in February and March. This also varies in stature, having stems from half a line to half an inch long; sometimes simple, sometimes branched, with a fruit-stalk two or three lines in length; and, though it chiefly bears solitary capsules, sometimes two and even three are found growing together. These capsules are sometimes very short, broad, and wide-mouthed, at others oblong and truncate. The leaves are more or less spreading, widely lanceolate, often wider above the middle, oblong and acuminate, with a reflexed margin, the nerve most frequently sub-excurrent, but occasionally ceasing below the apex.

Wilson remarks that a variety of this moss sometimes occurs in wet seasons, "with the stem branched in a fasciculated manner, with six or eight branches, each bearing a capsule."

The lid is obliquely rostrate, and convex at the base.

Another member of the family fruiting in February is *Pottia Wilsoni*, the *oval-fruited Pottia*. It grows on banks in a sandy soil, intermixed with the larger variety of *P. truncata;* was found by Mr. Wilson on rocky ground near Bangor and Carnarvon; also near Llanfaelog and Holyhead in North Wales; by others in Sussex, near Wrexham, and near Over in Cheshire. It is supposed not to be unfrequent, but liable to be mistaken for *P. cavifolia* or for *P. truncata*. In aspect, however, it differs considerably from the latter, growing in close, round, convex tufts, of a pale, glaucous colour; whereas *P. truncata*, though occurring in similar situations, presents extended flat patches with dark green foliage; and, while the leaves of *P. truncata* are quinquefarious, those of *P. Wilsoni* are octofarious. The nerve, too, is more excurrent, forming a mucro equal to half the width of the leaf. The areolation of the leaf is opaque and small in the upper part, larger and dia-

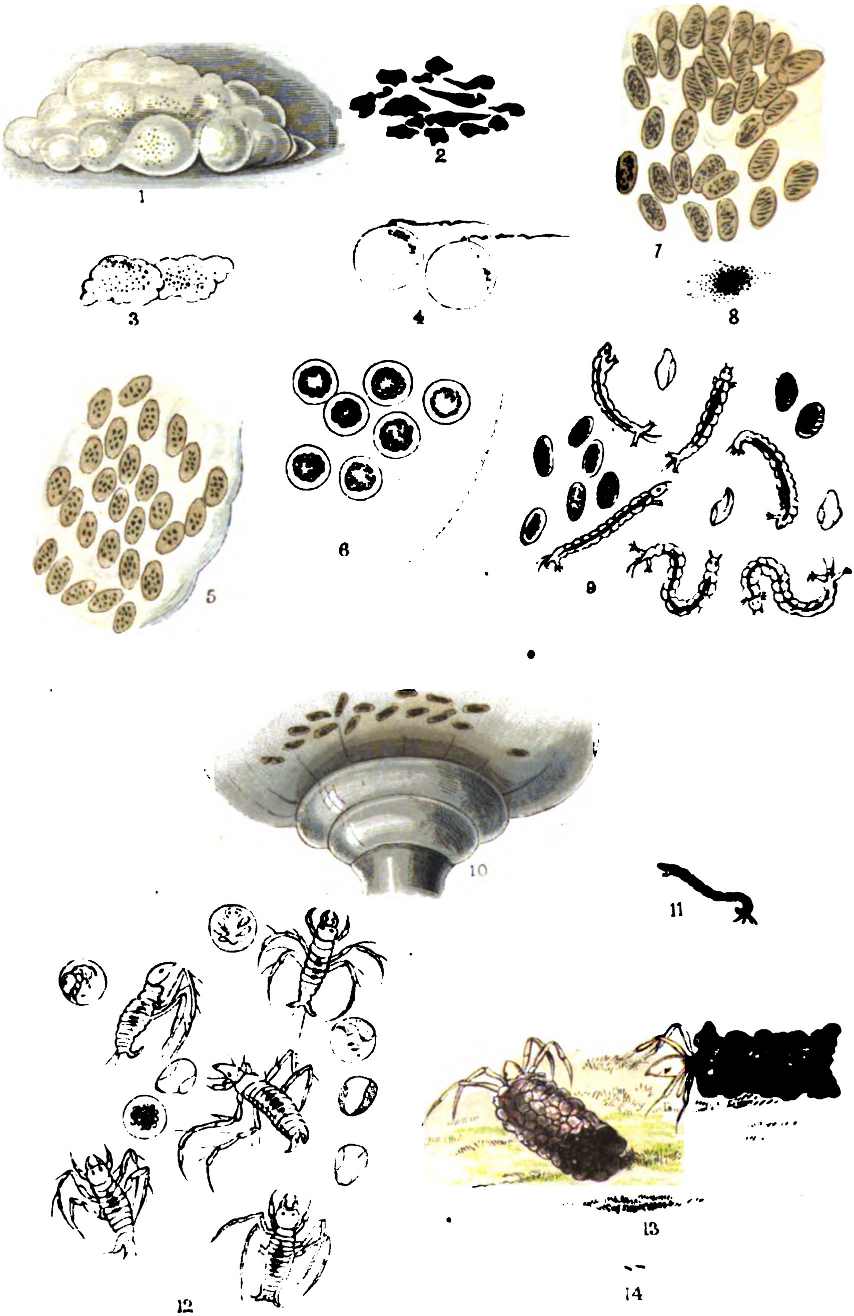
phanous towards the base. It also differs in the inflorescence, *P. truncata* bearing gemmiform, barren flowers, while *P. Wilsoni* has naked antheridia, and fruits nearly a month earlier. They need not, therefore, be confounded; and the peculiar structure of the leaves of *P. cavifolia* easily distinguishes it when placed under the microscope.

Pottia crinita, or *bristly Pottia,* is another which bears fruit in February, with stems more densely and compactly tufted than *P. Wilsoni,* and very obtuse, octofarious leaves, in this respect not unlike *P. Wilsoni,* but with a stronger rigid nerve, running out into a much longer bristle point, twice or thrice as long as in *P. Wilsoni,* scarcely opaque; the areolæ larger, capsule elliptic-oblong, scarcely contracted at the mouth, having an oblique rostellate lid, a smooth calyptra, and naked antheridia.

Pottia Heimii, the *lance-leaved Pottia,* inhabits moist banks near the sea, and is rarely in fruit till April or May. This is a taller species, but, like its congeners, it varies considerably, differing in the size, shape, and direction of the leaves, as well as in the length of the capsule and lid, while the fruit-stalk is sometimes less than half an inch, at other times an inch long.

The stems are more or less branched, the leaves concave, lanceolate, denticulate, or serrated at the apex, which is acute; margin plane, not recurved; the nerve reddish, scarcely at all excurrent, and the inflorescence polygamous, having the barren and fertile flowers variously disposed on the same individual; the flowers frequently synoicous, sometimes entirely barren; in which case it is destitute of paraphyses. When both organs are found united in the same flower, they are accompanied by subclavate paraphyses, longer than the antheridia. The capsule is of a reddish brown, erect, obovate, or oblong and truncate, not at all contracted at the mouth; the lid obliquely rostrate, and adhering to the columella.

We have thus completed the review of this minute, variable, but interesting genus, as far, at least, as British examples extend.



"A Windfall for the Microscope."

A WINDFALL FOR THE MICROSCOPE.

BY THE HON. MRS. WARD.

(*With a Coloured Plate.*)

ANY one who (whether truly or otherwise) has acquired the name of a naturalist is liable to be asked concerning a jelly-like substance occasionally appearing in sufficient quantity to attract observation. The question sometimes will be, "What is that jelly which falls from the sky?" as though that method of deposition could alone account for its sudden appearance.

In answer, we have generally to say on being shown a specimen, that the jelly alluded to has certainly not fallen from the sky, and can pronounce it to be the plant described by Linnæus as *Tremella nostoc*, and variously named by other authorities *Nostoc*, *Tremella*, "witch-butter," and "shot stars." This Nostoc is of a brownish-green colour, and, with a high magnifying power, proves to be composed of a multitude of very beautiful beaded filaments, lying in gelatinous fronds. These filaments, it would seem, rapidly subdivide, and in this way increase, while new fronds form around them when favoured by damp. "They frequently," says Dr. Carpenter,* "attain a very considerable size, and as they occasionally present themselves quite suddenly (especially in the latter part of the autumn on damp garden walks), they have received the name of 'fallen stars.' They are not always so suddenly produced, however, as they appear to be; for they shrink up into mere films in dry weather, and expand again with the first shower."

The inquirers will, perhaps, be content with this explanation; but possibly the objection may be raised that Nostoc is not the only kind of jelly, and they have seen some of quite different appearance. Possibly, then, a story which I have to tell of some jelly found under circumstances of undoubted isolation, and in a place where nothing of the sort had existed a few hours before, may throw light on the matter. It happened a few years ago, and I took such notes as I judged of importance at the time, making careful drawings of the mysterious substance, and the unexpected changes which it underwent.

To proceed, then: On the 20th of August I received from a friend fourteen miles off a little bottle containing a pale, jelly-like substance (Fig. 1), and a paper containing about thirty black grains, at first sight much resembling dry tea (Fig. 2). The information my friend sent with them was that they had been found on the deck of his yacht, the vessel being

* *The Microscope and its Revelations*, p. 338.

moored as usual at some distance from land in an inlet of Lough Ree, county Westmeath.

I placed the jelly carefully in a tumbler of rain-water, and perceived that it was composed of small, roundish masses of two kinds, one containing minute brown particles (Fig. 3), and the other green (Fig. 4), and both bearing a general resemblance to miniature frog-spawn. The masses containing green particles were each attached to a cord-like fibre, and were more compact than those with brown. The resemblance to frog-spawn recalled to my mind a dried specimen which I had lately seen of the plant *Batrachospermum,* and had the effect of leading me to refer them at that time to the vegetable kingdom.

The microscope did not throw much light on the matter. With a magnifying power of fifteen diameters, it showed the brown spots as in Fig. 5, and the green as in Fig. 6; but it helped me to make out something about the black, tea-like grains (Fig. 2). These proved capable of being softened; a grain, placed for a few minutes in water, separated into oval particles, very similar to the brown particles of the jelly, but flatter, as if from drying and mutual pressure. (Figs. 7, 8.) The idea at once suggested itself that it had been exactly similar to the jelly; but, from being exposed to the sun, had dried and hardened.

I wrote to ask a few questions about the finding of the jelly and black grains, and ascertained the following particulars:—

The boatman whose duty it was to scour the deck each morning was repeatedly annoyed by finding spots of jelly (which he compared to "small star-fish") lying on the deck, sail-cover, etc. He at first thought he had taken it up when wetting the deck with water from the lake; but, when the weather became so rainy as to make this artificial wetting unnecessary, he still found them.

On two mornings, instead of jelly, the black grains were found. My correspondent went on board his yacht on one of these occasions. The morning was fine, and the grains felt hard like glue, and came away easily from the wood when a penknife was passed beneath them. When they lay on a flat surface they were rounded like drops of sealing-wax; on sloping surfaces they were elongated; for instance, those lying on the middle of the cylindrical "sail-coat" which covers the mainsail when furled, were round, while those at its sides appeared to have run down, as dropped glue would have done. My informant did not observe any grains on ropes in a vertical position, or on the mast; but he noticed a coil of perfectly white rope spotted all over with them. The boatman said he thought the black grains appeared in rather greater quantity

than the jelly had done; he also remarked that they were most abundant near the stern of the vessel, just where snow with a little wind, or small hail with a good deal of wind would have been sure to collect; but this remark refers only to their *position;* the total *quantity* was much smaller than a deposit of snow or hail would have been.

Having now fully detailed the antecedents of the jelly, I proceed to the second part of my story. I left the jelly for five days in the tumbler—out of sight, and, I believe, to a certain extent, out of mind also; and the small portion of that with brown particles which I had last examined with the microscope remained still in the "animalcule cage," slightly flattened between its two discs of glass.

On placing the animalcule cage under the microscope on August 25th I saw with sudden surprise that several singular-looking *larvæ* had made their appearance among the jelly. That they had been produced from the brown particles was evident, as many empty shells were visible, and other similar larvæ could be discerned ready to come out of the particles, or *eggs,* as they may in future be called.

Fig. 9 shows the larvæ, the eggs, and the "empty shells" above alluded to. The eggs display the cellular structure so commonly observed in minute aquatic insects and animalcules.

These larvæ were remarkable for their transparency, reminding the spectator of Dickens's observation with reference to *Marley's ghost,*—"His body was transparent, so that Scrooge, observing him and looking through his waistcoat could see the two buttons on his coat behind!" I at once recognized their forms as familiar to me. A similar insect, with its strange, seal-like head and tiny pairs of feet (seal-like also) has often thrust itself across the field of view—a giant among pigmies—while I have been examining minute animalcules with one of the higher powers of the microscope.

The larvæ appeared perpetually struggling to free themselves from the jelly, and always incommoded by the slippery glass above and below them; except when they indulged in a lively dance in the surrounding drop of water. Their gait in this movement having reminded me of the common "bloodworm," Fig. 11 (larva of *Chironomus plumosus,* an insect nearly allied to the gnats), I obtained one of the latter from a water-trough which abounded in its mud hiding-places, and observed that the new larvæ were very similar to it.

This gave me a hint for the more comfortable establishment of the little Westmeath strangers. I placed them in a wine-glass half full of stagnant water, strained through muslin to guard against the presence of larger, and possibly hostile insects; and to the same miniature aquarium I removed the

"brown particles" from the tumbler, observing that a similar change had taken place among them. In less than half an hour numbers of the little larvæ had rolled themselves in mud cases (Fig. 10).

Meanwhile the green particles remained unaltered. On the 31st, however, their contents as seen through the microscope seemed to assume a more defined shape. As may be supposed, they were inspected daily with much curiosity. On the 2nd of September the uniform green spots, so often watched, were evidently seen to be exchanged for *something moving*. It was one of the excitements of a microscope to guess what appearance they would have when magnified.

Fig. 12 represents what the microscope showed when they were conveyed to it, and the form at first sight reminds one of a crayfish, or lobster; but they proved to be the "caddis-worm," larva of the caddis-fly. The immensely long, jointed legs, alike suited for building the well-known habitations of the caddis-worm, and for walking nimbly among water-weeds, and the soft body, evidently requiring defensive armour, were soon recognized.

I placed them in a glass, stocked with what I believed to be the materials of their trade; and at first they floated somewhat helplessly on the surface of the water. Ere long, however, these young creatures began very properly to make their clothes; or, as one may say, to build their houses, for these were real *buildings*, although no larger than those represented at Fig. 14. The reader may imagine how small the grains of sand must be of which they are constructed. At Fig. 13 these tiny edifices may be seen magnified fifteen diameters.

The jelly, then, was no other than the eggs of insects, and its appearance corresponded with some descriptions given by Westwood.* He speaks of the eggs of one of the Chironomus family as deposited on the leaves of aquatic plants, and covered with a mass of gluten; and he says of the caddis-flies (*Phryganeidæ*) that they deposit their eggs in a double gelatinous mass, which is of a green colour, and he adds that the female of *Phryganea grandis* has been observed to creep down the stems of aquatic plants under the water, for the purpose of placing her eggs in a desirable position.

The young caddis-worms which emerged on September 2nd were alive and well a fortnight later, and had enlarged their cases considerably. Unfortunately the story ends here. I was called away from home, locked up the wine-glasses which contained the two kinds of larvæ,—found them dried up on my return, and was unsuccessful in my attempts for their resuscitation. But I think it will be pronounced that I had

* *Introduction to the Modern Classification of Insects*, vol. ii., pp. 62, 516.

the advantage of having watched a curious part of their history.

And now, after all, how did the jelly get upon the deck of the "Dulcinea"? No doubt *Chironomus* and *Phryganea* deposited their eggs there; but why so recklessly over sail-coat, coil of rope, and deck, instead of in the lake close at hand? *That* I do not attempt to explain, but merely state the facts as I observed or heard them.

MINSTRELS OF THE WINTER.

BY SHIRLEY HIBBERD.

There are not many, even among genuine inquirers and observers, who can exercise the needful patience to gather knowledge for themselves on the subject of winter birds. A man who has spent six days in stalking a "muckle hart of Benmore," or who has passed a night in a hunter's lodge on the shore of a lonely mere in Le Morvan, or has endured wind, rain, and hunger in angling for grayling beside a poor swim on the banks of the Wye, the Dove, or the Ribble, may be able to sit still for hours on a muggy December day, or during the prevalence of a north-easter in January, and make notes of what birds move about among the dead leaves and fern in the copse, or try their luck beside the frozen brook, or sail high in the heavens, screaming more discordantly than the wind, on their way to discover a land of plenty, when frost has made a more terrible dearth than a burning drought in summer time. It is not at all a barren occupation to sit at a window overlooking an open country or a well wooded garden, and by the aid of a short-focus telescope, take note of all the birds that come and go, how many robins, blackbirds, thrushes, how many less-known aves flit across the scene, or pause for a season and explore for sustenance, and perhaps whistle a merry song, or engage in a small encounter—though birds rarely fight in winter—and thus acquire somewhat of a notion of the ornithological wealth of the district. One thing I know by experience, that if the residents in the suburbs of London, especially those dwelling three or more miles from St. Paul's, were to engage themselves in this very quiet and in-exciting recreation occasionally, they would derive considerable satisfaction in learning by observation, that many more birds visit the gardens in the suburbs of London, as, indeed, of all large towns, than is usually supposed; and this knowledge might make many more contented with their lot who are now

bitter with dissatisfaction at the rapid growth of towns and the change which is passing over all things rural. I am often amused at the look of astonishment with which friends sometimes receive my verbal accounts of birds that visit my garden, but I am not surprised that they find it hard to believe, and disposed to receive the narrative as a joke, for I sometimes hear one say, "I haven't seen a robin the whole winter through," though the speaker lives, perhaps, in an open rural spot, where a bird-catcher could make a good living, if allowed to put down traps in the garden for robins only. The fact is, the majority of people go through the world with their eyes shut. Intellectual observers are thinly scattered, and it is as yet known but to few how abundant and how cheap are the sources of human happiness.

Not that an observer now pressing his nose to the window pane, or chattering his teeth on a bleak common, would see or hear a great many birds. The great flocks of harvest finches that winged their way across the stubbles like driving showers, appearing and re-appearing as they were disturbed by the sound of wheels, or voices, or guns, have all dispersed; the plough has broken up their pastures, and they, for the most part, forage for themselves singly, or in very small parties, the males and females being for the present separated. In the gardens there are fewer birds of all kinds, even blackbirds, thrushes, and sparrows are scarce, and, what is worse, they are *quiet*. From the end of October to the end of January, the country is as quiet as it is leafless, indeed, more quiet than leafless, and the silence is oftentimes oppressive, especially when far into November and December the meadows are still as green as in April, many trees still holding their leaves, and the sky bright and blue, with soft breezes blowing, and everything, except the birds, affecting to consider winter an impossibility. But there is no hypocrisy among the birdies, *their* winter has come, and they wait without murmuring the return of spring; and because of this silence I think it well to gossip a little on the song birds of winter; for happily there are a few, and Nature has ordered it that no day or hour in the whole year round should pass without some sort of voice to serve it for a chronicle.

"What are the birds now to be heard? Tell us," you say, "about the minstrels of the winter, their names, their features, and their songs." On just such a day as I write this, December 18th—barometer 30·41, thermometer in the shade, 42°—the sun shining brightly in a cloudless grey sky, breeze from the north-east, brisk enough to keep all the windmills clacking—on just such a day I was sauntering beside the Avon at Ringwood, in the New Forest, wondering how the cows could

manage to get so fat on potamageton and other water plants that they always feed upon there, when suddenly I was startled by a splash, and saw a little bird dash into the clear stream beside me, and fly along the green weedy bed with the swiftness of an arrow, then emerge, fly upwards, and alight on the bough of a willow overhanging the water. There for a moment he was busy jerking down his throat some sort of food he had captured during his brief submergence, and then he broke out into such a clear ringing song, that I might have fancied the whole affair a dream, or the bird an angel in disguise. I remember the event the more particularly, because, till then, I always believed the water blackbird (*Cinclus aquaticus*) to be exclusively a native of the highland glens, where it overpowers the roar of the waterfall and the muttering of the mountain breeze with its rich, wild melody, loudest among the feathered minstrels of Britain. I soon lost my friend ; he vanished as suddenly as he appeared, and but once since have I seen this most curious, most rare, and most musical of all the minstrels of the winter.

Bechstein describes the water-ousel as a favourite cage-bird with the Germans, and Macgillivray, greatest of word painters, tells of its habits as observed by him among the fastnesses of the north. In form and features this bird resembles a starling more than a blackbird; the head tapers towards the beak, the beak is long, flattish, and black, the head and neck are of a rusty brown, the rest of the upper part of the body is black, with an ashy tint, the quill feathers and the very short tail are black, breast pure white, shading into deep maroon, and that again shading into black, which extends over the belly. It is a peculiar bird; when looking forward in a half crouching attitude, and for a moment motionless, it has the look of a hungry charity boy with a bob-tail coat; but when it lifts up its head and stands almost erect, showing its broad white breast, to pour out its rich mellifluous song, there is a pride and daring in its attitude befitting a bird that loves best the mountain breeze, the brawling brook, and the foaming waterfall. It haunts the stream in the capacity of a fisher, and its food is principally the spawn of trout and salmon, and this it seems to take during its flight-under water, and without needing to pause where it is impossible it could continue for more than a few seconds at a time.

Another real minstrel of the winter is the missel-thrush, which I mention with less of the pleasure I should otherwise experience, because I have found it impossible to cultivate mistletoe in my garden at Stoke Newington through the vast increase of London smoke, consequent on the growth of buildings on every hand. The China rose was the first to feel the

shock, now the mistletoe, which used to thrive in these parts, begins to show signs of sickliness, and when we lose that we must say farewell to the missel-thrush, or rather he will take farewell of us, and we shall miss his boisterous song. Hitherto the missel-thrush (*Turdus viscivorus*) has been a constant and a frequent visitor at Stoke Newington, and all the gardens of the northern suburbs. He is indeed fond of the suburbs of London, and often seen at Brixton, Tulse Hill, Sydenham, and other spots which still retain a show of rurality. But though fond of mistletoe berries, there is no necessary connection between the bird and the druidical plant; and if we lose the missel-thrush it will not be because the mistletoe has perished, but because the new houses interpose a barrier between us and the open country. Every winter during the past seven years I have not failed to see the missel-thrush in the garden half-a-dozen times at least, and it is some satisfaction to know that a great boss of fruiting ivy, which bears berries most abundantly, is an attraction to this and other winter songsters, and no increase of building will destroy that or render it less fruitful. Very few birds are gregarious in winter, two or three blackbirds and song-thrushes may sometimes be seen on the lawn at one time, and occasionally a dozen sparrows will forage in company among the rhododendrons; but the storm-cock is loneliest of the lonely—an emblem of solitude—for he comes alone, he comes at times when most other birds are cowering for shelter in unseen retreats, and for a thrush of any kind his size is so vast and his aspect so daring, that there is a charm about his solitariness, and his loud, melancholy, monotonous song is as appropriate to his whole character and habits as to the dreary season when he most rejoices to utter it. It appears not to have been noticed that this bird plays the hawk occasionally among the minor minstrels, and is at times as much feared by small birds as the buzzard and the kite. I have seen a missel-thrush make a dash into a bed of American shrubs in front of my drawing-room windows, and put to flight a score or more of sparrows with expressions of alarm, as if a bomb-shell had fallen amongst them. White remarks upon its pugnacity during the season of nidification, "driving such birds as approach its nest with great fury to a distance. The Welsh call it *pen y llwyn*, the head or master of the coppice. He suffers no magpie, jay, or blackbird to enter the garden where he haunts, and is for the time a good guard to the new-sown legumens." This last note has strangely escaped the notice of the advocates of birds against the destroyers who make no exception in their wholesale devastation, by trap, poison, and gun. But it is not in the breeding season only that the storm-cock is pugnacious; he is at all times a hater of birds, even of

his own race, and, like the robin, leads a lonely life, knowing no fellowship except with his mate while love rules him, and to her showing an attachment as ardent as his hostility to all else is unscrupulous and savage. But he is a "noble savage," and when fairly in song, which does not happen till the new year turns, rejoices to peal out his loud, wild, and mournful notes when every other bird is silenced by the keenness of the wintry blast.

Occasionally in the vicinity of villages, and in well-wooded gardens, the winter days are enlivened by the notes of the woodlark, the wren, the gold-crowned wren, the robin, and small companies of wandering finches. But the extent to which these become musical, indeed the degree in which they visit the abodes of men, depends much upon the weather, and there are times when during frost, fog, and snow, no birds capable of a musical note save the sparrow and the robin are ever seen. Where they hide at such inclement seasons no man can tell, but that many of them perish in hard winters is but too well known by the finding of their dead bodies sometimes in dozens and scores, sometimes in hundreds, in sheltered nooks to which they had resorted for mutual protection, and to perish of want in a community of misery. Even when no such terrors threaten them, the dull weather so common to December makes them all mute, and it is only on those halcyon days when the sun breaks through the gloom, and makes a momentary spring-time, that we are reminded by their music that the world is still peopled with happy feathered creatures. Song birds are not such victims of blind unmeaning impulse, not such mere creatures of instinct as to sing, as Tennyson says, "because they must." They participate with us in the depression consequent on gloom, and the cheerfulness that accompanies life and light; and it is because during December the world is more dead in the aspects of the sky and the state of vegetation than at all other seasons, that then nature is most silent, in a certain sense the grave has closed over all things lovely, and the birdies are buried with the flowers. It is not lack of food, but lack of sunshine that causes the general silence of December; fog is more depressing than frost, and the minstrels that are still capable of song take their moods from the state of the elements, and are simply silent when it would be out of taste to sing. It is worthy of notice in this connection that we celebrate the most joyous festival of the whole year at a time when the aspect of heaven and earth are most depressing, the origin of Christmas lying far back and beyond the blessed history of which it is now the brightest outward symbol, and in some sense but a continuation in an altered form of those Pagan feasts in which the holly, mistletoe, and ivy were originally consecrated as emblems

of rejoicing. Still with all the dulness of the time, some songs prevail, and when the resident birds have played their parts in the meagre wintry chorus, there are many sojourners that have a song to sing, and a few words will suffice to enumerate all but a few that make themselves conspicuous by their bravery and gaiety.

Let us not forget how courageously the smallest of British birds defies the winter, and is always in a merry mood. The common wren (*Motacilla troglodytes*, Linn.) is as common in the gardens at Stoke Newington as the robin and the thrush. On a sharp winter it is a common occurrence to see half a dozen at a time scuttling along the top fringe of the ivy fence, or bustling about among the dead leaves under the evergreen shrubs, looking like mice, and uttering a very mouse-like squeak, which, like a stray primrose or lingering chrysanthemum, is the more welcome, because there is then little competition, and we are glad of any noise out of doors that is not positively discordant. Neville Wood does real justice to this miniature of a songster. He says, "the song is short, shrill, and remarkably loud in proportion to the size of the bird. It may perhaps be ranked amongst the most trivial of our feathered choristers, but the notes are more prized than they would otherwise be on account of their being frequently heard in mid-winter, when a mere scream would almost seem sweet, especially if it proceeded from the throat of so tiny a bird as the ivy wren. And thus insignificant and humble (with regard to musical merit) as are its strains, I always listen to them with delight in the dreary seasons, though we are apt to overlook them altogether in fairer times." The gold-crowned wren (*Regulus aurocapillus*) I have seen but once here, and that was in the winter of 1858, during a dark drizzly day, when the bird appeared suddenly toying among the branches of a thorn near the window, as if wholly unconscious of the cold, though it is known to be the most susceptible to cold of all the British birds, and looking for the moment as if a stuffed humming bird had suddenly come to life and escaped from a glass shade. After sporting among the shrubs for several minutes, this "winged gem," remarkable for its minuteness, pertness, and the brilliant colour of its crest, made its way in a sort of jerking flight across the garden, shone for a few seconds like a flame on the ivy, and then with a small sound like the creaking of a wheel at a distance made its way towards the distant meadows. I have rarely travelled far in winter in any part of Herts or Surrey without seeing one or more specimens of this pretty bird in the course of a journey; but I never heard it really sing until after the turn of the year, and then to understand the scope and character of its song the listener

should be motionless, or the bird will be mute. In plantations and copses it may generally be met with, and it will always repay the rambler to take a seat on a stone or the stump of a tree, for a chance of a visit and a performance, for the gold wren is inquisitive, and will approach near to the stranger, and sing its small soft, sweet song within a few paces of the listener so long as he maintains comparative stolidity.

Among the winter visitants the fieldfare must take the lead for the excellence of its notes, and perhaps the greenfinch should have the next place, not for sweetness, but garrulousness. The fieldfare-thrush (*Turdus pilaris*) is a handsome bird, with a lively expression and a beautifully dappled breast. It comes with the redwing in October, and leaves us for its Scandinavian breeding grounds some time in April, though both it and the redwing occasionally continue later. The fieldfares go from field to field in vast flocks, preferring open flat countries, and not often separating to visit gardens, though I have seen solitary individuals of both species shot in gardens near London. Ordinarily when these flocks pass, the only notes heard are the call notes, and these are sufficiently unmelodious to deter one from criticism. Opinions differ as to the value of its song. Mr. Wood speaks of having kept one in a cage, but he never heard it sing, "if you had seen it you would have supposed it had some deep project in its head, so wise and solemn did it look." Mr. Blyth says, "its song is a mere chatter." Bechstein says, "its song is a mere harsh and disagreeable warble." Mr. Broderip says, "the song is soft and melodious, and the bird sings agreeably in confinement, to which it soon becomes reconciled." I once had an opportunity of putting these various statements to the test of experiment, and the result was this, that individuals differ considerably in their powers of song; but what is of more importance is this, that there are few bird-fanciers who can distinguish males from the females, and so hen birds are sometimes caged, and hence an unfair verdict upon the musical capabilities of the species. As to caging it, it is the easiest thing in the world, and take care not to give it more food than needful, or it will grow fat and die of heart disease. There are other points of interest in the history of this bird: it has never been known to breed in this country, and in its own Norwegian forests it builds in forks of the fir, and large numbers associate together. Sir Walter Scott makes a strange exception to his usual accuracy of description, where, in the "Lady of the Lake," he describes it as breeding in Britain, and making its nest on the ground—

"Beneath the broad and ample bone,
That buckled heart to fear unknown;
A feeble and a timorous guest,
The fieldfare framed her lonely nest."

Among the rarer birds that visit us in winter, and by cheerful notes break the sullen monotony of the dreary season, the silktail, the grosbeak, the snowflake, crossbill, mountain finch, and mountain linnet, may occasionally be seen and heard by observers well situated, and the counties of Surrey and Hants are more often favoured, perhaps, by these rare visitants than any other parts of England. I used, when a boy, to catch in the meadows of my native village of Stepney, meally redpoles and greenfinches in numbers greater than I care now to remember, especially as the remembrance includes not only the catching, but the unhappy fate of those birds; for we used sometimes to harness them with twine and have them at school with us all day, sometimes hidden in our sleeves, when the dominie's eyes were to be deceived, and at other times thrust down a boy's neck when there was opportunity for a trick, or a piece of vengeance. Traps and cages were made of impossible materials, a dozen or more unhappy prisoners were pent up in cages not large enough for one to move about freely in, and left to fight, or starve, or perish as they might. We are sometimes beguiled into a wish that we could be "boys once more," but there is no man with a spark of true humanity who would purchase back the joys of boyhood if it were inevitable that we must also be as cruel as a boy; and, alas, it must be said that as a rule, boys *are* cruel, implacably cruel, and inventively wanton in inflicting cruelty on animals, and from the act deriving a pleasure so intense, as to prevent reflection and stifle the voice of conscience, which has some force, even in infants. The redpole (*Linaria pusilla,* Blyth) is both resident and migratory; in the midland it is common throughout the year, frequenting groves and streams; in other places it appears only as a winter visitant, and it is in this character only I have made its acquaintance. The flocks we used to thin made their appearance in December and January, on the site now occupied by the Metropolitan Cemetery and the town which joins it on one side, and which in my "boyish days" consisted of meadows and market gardens. There we used to see them in vast flocks, shifting about in compact masses, and uttering a pleasing but confused song, as soon as they alighted on the hedgerows and bushes, from which, on the slightest alarm, they would take wing, and in their progress mingle sundry call-notes with small snatches of song. On the other hand, the greenfinch (*Loxia chloris,* Linn.) has always been known to me as less gregarious in its habits than the redpole, or, indeed, any other of the finches; and though it is a resident, it is only as a winter visitant I have had opportunities of observing it sufficiently to become familiar with its habits. It is a beautiful and lively bird, no whit less attractive in habit and song

than the goldfinch or the chaffinch, birds of no mean repute; but, unfortunately, the call-note of the greenfinch is abominably harsh, and so piercing, that it may be heard at a greater distance than the call of any other bird, and is often useful as a warning to birds of other species, as well as to the individuals of the flocks of half-a-dozen or so which frequent the London gardens during the winter.

Thus, in spite of its being true that the winter has few songs, I have, I hope, shown that it has some music to cheer the heart of man, and encourage the observer to continue the search for knowledge, even when the opportunities for its acquirement are few and far between. Nor is the list of winter song-birds exhausted. The crossbill occasionally appears, in company with the hawfinch, in our pine woods; and these are the two most interesting of all the rarer birds of Britain. Great is my debt to them for amusement freely afforded by their pranks and melody, when they have figured among my household pets, as greatly prized as any. There is the siskin, also rare, but liveliest of the lively—a bird with a merry heart and a vein of comic humour quite in keeping with the queer character of its twitter of a song. And if all these were silent, we should have the sparrow and the robin, friends that fail not, that a hard winter never annihilates, and that seem to be of kindred, morally, with the redoubtable Mark Tapley, for they are "jolly" under circumstances the most adverse to merriment. But why mention them together? they are no friends, and the first is but a chattering thief, while the other is the bravest, the most individual, independent, jovial, and melodious of all the winter minstrels. No wonder the robin is the most renowned in story, and the most sacred in the household mythology, for his mellow song is like a ray of sunshine during a season of darkness, or, as Emerson says, speaking of things altogether foreign to this subject, "like music heard out of a workhouse."

SALT MARSHES AND THEIR INHABITANTS.

BY GEORGE S. BRADY, M.R.C.S.,

Secretary to the Tyneside Naturalists' Field Club.

THERE are in our comfortable land few scenes more dreary and depressing than an extensive salt marsh, especially if seen under unfavourable conditions of weather. The monotony of a vast expanse of moorland is broken by undulations of its surface, by the purple flush of heather, or the golden glow of blossoming gorse; and even if there be none of these it becomes grand rather than dreary in its very immensity, and the ever-varying play of light and shade upon its many-tinted vegetation, gives it an indescribable charm. But let us change the scene. Picture to yourself a bare expanse of cold, oozy soil, clothed with scanty, stunted vegetation of a dull grey-green hue, with patches of treacherous mud, into which one may very easily sink up to the knees before one has time to invoke the shade of "Jack Robinson" (whoever that mysterious worthy may have been); here and there a sullen, shallow, brackish pool, with bottom of black peat or mud; bits of old worm-eaten wreck strewed about, and sinking month by month deeper into the unstable soil; cast off shells of shore-crabs bleaching in the sun, and crunching beneath the infrequent footstep; no sight or sound of life except a few sea-gulls or lapwings circling overhead, and only adding to the "eeriness" of the scene by their melancholy cry. All this is sufficiently doleful, and with a dull leaden sky, and the breath of a chill sea wind, one has need of a considerable share of the spirit of Mark Tapley to keep "jolly" under the circumstances.

However, to the naturalist there is abundant interest in localities such as these. Though the vegetation is so poor and stunted, we find on closer inspection not a few interesting and peculiar plants, and we are at once struck with the fact that many of them are remarkable for their excessively fleshy and succulent leaves. Perhaps the commonest of all is *Glaux maritima*, a modest little plant with pretty but inconspicuous pink flowers, or rather, we should scarcely say *flowers*, for petals are wanting, and the apparent flower is merely the flesh-coloured calyx. Then there is *Salicornia herbacea*, with its thick, tumid leaves, which often obtain for it, though incorrectly, the name of Samphire; the true Samphire (*Crithmum maritimum*) being essentially a rock-loving plant and growing often in the most inaccessible positions, as Shakspeare well knew:

> "Half way down
> Hangs one that gathers samphire, dreadful trade:
> Methinks he seems no bigger than his head."

More showy than these is *Aster tripolium*, which, with its mauve petals and brilliant orange disc, does the best it can to lend some liveliness to its chosen haunts,

> "Making a sunshine in a shady place."

Some of the *Arenariæ*, too, we may find (*A. marina*, or *A. peploides*), not without a quiet beauty of their own, but certainly less attractive than their rarer neighbour the Sea Lavender (*Statice limonium*), which, with its beautiful spikes of blue and white, is after all not so lovely a flower as its near relative, the common Thrift (*Armeria maritima*). Thrift flourishes nowhere so well as on cliffs overlooking the sea. The Preraphaelite artist could scarcely find a more delightful study than a luxuriant bed of this plant carpeting the sides of a rugged rock, its glow of tender crimson intermixed with the beautiful white of the Sea Catchfly (*Silene maritima*). But we find it likewise growing freely in the salt marsh, on the mountain-top far inland, and under cultivation in our gardens. It seems, indeed, to be one of the most hardy and accommodating of our indigenous plants. We might much prolong this list of flowering plants peculiar to, or very common inhabitants of, salt marshes, but must dismiss them with the mere mention of the genera *Atriplex* and *Plantago*, both of which will commonly be found represented. The Cryptogamic flora, however, deserves further attention. In the spongier parts of the marsh we find the roots and rhizomes of the grasses matted together by a dense growth of *Vaucheria*, one of the green Algæ of a genus which inhabits indiscriminately fresh, brackish, and salt water. The plant puts on many different forms and habits, according to the kind of locality in which it grows, and many of these varieties have been elevated to the rank of species on very insufficient grounds. *Vaucheria* is certainly one of the least beautiful, perhaps also one of the least interesting of its class. It consists of branched tubular filaments, filled with a green endochrome, and without articulations. The filaments are mostly inextricably matted together, forming a dense cushion, so that the base of the tuft being excluded from the air and buried in mud, becomes yellow and gradually decays, while the upper extremities, continuing their growth, are of a deep bluish-green colour. The only situation in which we have ever seen any member of the genus put forth much pretension to beauty, is on the sides of perpendicular rocks, where it is nourished by the spray of waterfalls or runlets. In such places its green velvet fleece, often many

yards in extent, disposes itself in numberless tiny crests and undulations, which give an effect of exceeding richness to the rock surface. This plant is *V. cæspitosa*, that of the salt marshes, *V. velutina*. While speaking of Vaucheria we may briefly allude to the remarkable fact that living animals (*Rotifera*) have been repeatedly observed in the interior of the filaments, nor is there much difficulty in accounting for their presence in so unwonted a situation. When the tube of the plant ruptures to allow of the escape of a spore, or from any other cause, the opening so formed would be amply sufficient to allow of the ingress of a rotifer, either as an egg or in the mature state, and when once established in the filament there is nothing to prevent the animalcule breeding *ad libitum*, so that plants have been observed to be completely colonized by Entozoa of this kind. Intermixed with the marsh Vaucheria we often find a species of Oscillatoria, an alga composed of slender, unbranched, tortuous threads, which are faintly marked by close transverse striæ. Its filaments are of microscopic dimensions, being only one two-thousandth of an inch in diameter, and when viewed under the microscope they exhibit plainly the peculiar oscillatory and worm-like motions from which the genus derives its name. The origin of these movements is not thoroughly understood. They had been supposed to be due to ciliary action (a very convenient explanation by the way, of all sorts of anomalous, ill-understood movements), but are more probably referable to some contractility inherent in the tissue of the plant, perhaps analogous to that which we see in the sarcode of Rhizopoda, etc. At all events, no cilia adequate to produce such motions have yet been detected in Oscillatoriæ, and the motions themselves are very different in character from those which we know to be caused by ciliary action, such as the rotation of Volvox and the spores of many algæ. I am at a loss to conceive how any observant scientific man could explain these motions (or attempt to explain them), as Dr. Hassell has done, in the following words:—"The phenomenon of oscillation is due to a certain degree of elasticity belonging to the filaments, which leads to the effort, on their part, whenever, as on being placed for observation on the field of the microscope, must be the case, they are bent or put out of a straight line, to recover that position which is natural to them. This elastic property of the filament currents, almost imperceptible in the liquid in which they are immersed, and perhaps unequal attractions amongst the filaments themselves, are causes amply sufficient to explain any motion which I have ever witnessed amongst the Oscillatoriæ, and which motion I cannot help thinking to have been misunderstood and exaggerated to such an extent, as to throw around these plants

an unnecessary degree of mystery." A very simple observation would have shown Dr. Hassell that these motions take place naturally during the growth of the plant, and while it is free from any of those disturbing causes alluded to. Indeed, it is by these motions only that we can explain the very rapid spreading of the filaments over a large surface, which phenomenon may be easily witnessed both under natural and artificial conditions.

The oscillation is seen even more beautifully in a nearly allied genus, *Spirulina,* which may occasionally be found spreading over decaying leaves and other organic matters in brackish water, or in the sea near high-water mark. The plant itself is also much more elegant than Oscillatoria, consisting of a slender filament, twisted closely upon itself so as to resemble a very delicately threaded screw of a beautifully delicate green tint. Another very curious organism of the same group, and occurring also, though much more rarely, in salt marshes, is *Microcoleus anguiformis,* which may be described as consisting of a number of short threads of an Oscillatoria packed together into a bundle and enclosed in a tubular sheath, wide and open at one extremity, pointed and closed at the other. Out of the open extremity the threads protrude and oscillate, or they may even exhibit themselves from a rent in the side of the sheath.

If we scan closely the bottom of one of the black uninviting pools before-mentioned, we shall probably find that it is marked in patches, or it may be all over, with small closely-set holes, each of which opens at the apex of a slight eminence. The tubes with which these perforations communicate are, in fact, the habitations of a curious Amphipodous crustacean (*Corophium longicorne*), but whether they are really the work of the Corophium, or are merely taken possession of by the creature, as a hermit-crab takes possession of a deserted shell, is not so easily decided. I believe that the tubes are mostly excavated by a small annelid. At any rate, whole colonies of annelids may often be found inhabiting them. There is no doubt, however, that the Corophium has the power of burrowing very rapidly into soft mud, and it makes use of this faculty whenever it is alarmed and wishes to conceal itself; probably also when pursuing its prey. But though I have kept specimens in confinement for several days I never could find that they formed any regular tubes like those which we see them inhabiting in their natural haunts. There is a traditional enmity between Corophium and the Annelids, and it is quite possible that it may, after killing the architects, take possession of their burrows. So indeed, Pagurus has been said (but not proved) to do with the molluscan builder of its appropriated habitation.

Corophium longicorne is most commonly met with in the mud of brackish ditches, flat sea-shores, and estuarine swamps, but if the following passage from Quatrefages' "Rambles of a Naturalist" may be trusted, it would appear to be an animal of migratory habits. "Towards the end of April these little crustaceans, termed by the fishermen of the coasts of Saintonge, the *Pernis,* arrive from the open sea in myriads. Guided by their instinct, they come to wage an exterminating war against the Annelids, which during the whole winter and early spring have multiplied undisturbed. As the tide rises these voracious hordes are seen moving about in all directions, beating the mud with their long antennæ, and pursuing Nerides and Arenicolæ to their deepest recesses. When once they discover one of these animals, which are several hundred times larger than themselves, they combine to attack and devour it, and then resume their eager chase. This carnage never ceases till the Annelids have almost entirely disappeared. . . . . . Before the close of May the work is completed, and then the Corophium turns upon the molluscs and fishes, which it attacks, whether living or dead. Through the whole of the summer these crustaceans remain upon the coast, but towards the end of October they all disappear in one night, ready to return the following year."* To this account we may add that in some places, far removed from tidal influence, where we commonly find these little crustaceans, the migration spoken of cannot possibly take place. Probably the habits of the creature may vary according to the circumstances in which it is placed.

Another Amphipodous† crustacean, constantly met with in the pools of salt marshes, is *Gammarus locusta;* certainly not an animal of beautiful or interesting aspect. Its dull brown or greenish colour, its wriggling sideways motion when taken out of the water, and its habit (shared by other members of the family) of hanging together in couples, the large male carrying the smaller female about beneath him, holding her by his claws; all these give the creature a certain repulsiveness. Nevertheless, there are several very interesting points to be observed respecting it. In the first place, this genus (*Gammarus*) may be said to be the type of the whole class of crustacea. In it the several parts of crustacean organization are developed in the most symmetrical and orderly way, and may be separated and demonstrated, perhaps, more completely

* Quatrefages' *Rambles of a Naturalist on the Coasts of France, Spain, and Sicily,* vol. ii., page 312.

† The *Edriopthalma,* or sessile-eyed crustacea, are sub-divided into *Amphipoda* and *Isopoda,* the former being compressed laterally, and having feet adapted both for swimming and walking; the latter are flattened horizontally, and are specially formed for running. Of the first named group, the common Sand-hopper may be taken as the type; of the latter, the wood-louse or "Slater."

than in any other genus. The segments of the body and their corresponding appendages may be seen very clearly, there being little or nothing of that pressing together and consolidation of several parts which is so constantly exhibited in both the higher and lower orders.* We should scarcely expect to find in an animal of this grade much development of maternal instinct, and yet some observers have noticed such manifestations. The ova of crustacea are mostly attached in a considerable mass, to the abdominal or false feet of the female. In *Gammarus* (and in some other genera) they remain *in situ* for some time after having taken on the crustacean form, and even when able to swim freely, they will often hover round the parent in a little cloud, and when any danger threatens, again seek refuge amongst her legs. *G. locusta* is easily recognized by three conspicuous red spots on each side of the body, upon the abdominal segments. It is a very common species, but is almost confined to the upper portion of the littoral zone, haunting chiefly shallow tidal pools, and especially those heaps of decaying sea-weed which strew the shore between tide marks. In such situations it may often be found in countless numbers. Its range extends up tidal rivers to the utmost verge of brackish water, and it may even be met with in ditches to which salt water gains access only once or twice in the year.

A species of Sphæroma (*S. rugicauda ?*) is one of the most generally distributed crustacea of brackish water, and is, indeed, almost the only representative of the Isopods met with in such places. The species of this and some allied genera (*Armadillidium, Porcellio,* etc.) have the curious habit of rolling themselves into a little ball when handled, remaining motionless while in this position. The terrestrial species have obtained for this reason the trivial name of "pill beetles." It is remarkable that some of these animals are able to live indifferently, either in the deep sea or on dry ground removed from any marine influence. Thus we have taken *Porcellio scaber* abundantly on dry sandy hedge-banks, and likewise from the nets of trawlers in fifteen fathoms water. Such a fact is very curious and suggestive, quite as much so as many of the hypothetical cases put by Mr. Darwin in his work on the "Origin of Species," and which have been so much ridiculed by the opponents of his theory.

Among the Entomostraca of salt-marshes we find some very interesting species. One of the bivalved forms (*Cyprideis torosa*) was first described by Professor T. Rupert Jones, as a fossil species occurring in the Tertiary strata. Mr. Jones likewise took it living in ditches near Gravesend, and it has since been

* For an account of the structure of the skeleton of a typical Crustacean, *vide* INTELLECTUAL OBSERVER, vol. iii., page 38.

found abundantly in both fresh and brackish waters in the counties of Somerset, Durham, and Northumberland.* When it does occur it is generally in prodigious numbers; a fact accounted for by the unusually large number of ova which it bears. The peculiar ringed and serrated hairs which occur on the limbs of this genus and of *Cythere* are very beautiful and interesting objects for the microscope.

Cyprideis has no power of swimming, its motions being restricted to crawling; but some of the natatory Entomostraca are found in similar places. These are chiefly of the same family to which the common and well-known *Cyclops quadricornis* belongs. The males of these animals have the right antenna very strongly developed, and provided about the centre with a hinge-joint, so that it can be flexed and used as a clasping organ. In some species, to render the apparatus still more effectual, there is on each side of the hinge a plate armed with spines or serratures, by which the grasp must be greatly strengthened. The females may be seen toward the end of summer and autumn, carrying about with them, attached to the first segment of the abdomen, numbers of elongated cylindrical, or fusiform bodies of a yellowish or deep red colour. These are the "spermatic tubes," which have been fixed in that situation by the male; a curious mode of fecundation, which so far as we know is peculiar to this family of Entomostraca.

The highest, or stalk-eyed order of Crustacea, is represented in brackish water by three species—*Palæmon varians, Mysis vulgaris,* and the common shrimp (*Crangon vulgaris*). The last named is of almost universal occurrence, and calls for no special remark here; the other two species are comparatively rare. The Palæmon is much smaller than its congener, *P. serratus* (the common edible prawn), and also quite deficient in the beautifully variegated colouring which adorns that species. Like the rest of its genus, it is very timid and very agile, so that, except with a tolerably large net, it is difficult to catch it when in clear water. In muddy places the best way of getting specimens is to force the net into the mud, so as to enclose a considerable quantity; then on washing it a number of the prawns will probably remain behind. It is curious that although these creatures seem so much frightened at the sight of a net, they will, if one's hand is put quickly into the water and kept there for a minute or two, come boldly up to it, hovering about, and feeling it all over with their long antennæ. A crowd of them may be thus collected in a very short time, but the slightest movement makes them dart off rapidly, and I have always found it impossible to catch one in this way, even though

* *Vide* a paper by the present writer in *Annals and Magazine of Natural History*, January, 1864; also in INTELLECTUAL OBSERVER, vol. i. p. 454.

they will sometimes come and bask almost in the palm of the hand; probably the warmth of the hand is the attracting influence.

The species of Mysis, or "Opposum shrimp," mentioned above, living as it does both in fresh and strongly brackish water, brings before us a very interesting problem, and one by no means easy of accurate solution, yet concerning which we have some few data which may guide us to a right result. We find that most fresh-water genera possess also some representatives inhabiting the sea. And it at once strikes us that it must be something more than a merely fortuitous coincidence by which animals so far separated in their habits agree so closely in structure as to be included in the same genus. If Mr. Darwin is right, as we believe he is, in supposing that at least all genera of the same order are descended from one common ancestor, we must seek for an explanation of the present state of things by looking backward to some remote period when the progenitors of the existent fresh water and marine forms were not separated by the impassable barriers which now divide them. We extract the following interesting remarks on this subject from Messrs. Spence Bate, and Westwood's History of the British Sessile-eyed Crustacea (vol. i. p. 390). With reference to the facts which we have mentioned, these authors say: "The key may be suggested by the interesting discoveries of Cedarström, Olofson, and Widigrew, in the lakes of Vetter and Vener, in the south of Sweden, of which an account has been published by Lovèn. These two inland fresh-water lakes are situated on high ground, and have the surface of their waters 300 feet above the level of the Baltic, whereas the bottom is 120 feet below such level. In these lakes (which appear to have been lifted up with the gradual uprising of the country) have been found several genera and species of Crustacea, three of which are Amphipoda, which are affirmed to be identical with marine ones, namely, *Gammaracanthus loricatus* (Sabine, Ross, Kröyer), *Pontoporeia affinis* (Lindström), and *Gammarus cancelloides* (Gerstfeldt). The first is now only known to exist in the Arctic seas, the second in the Baltic, and the last was found in Lake Baikal, in Central Asia. It is therefore suggested by Lovèn that when the land was raised so as to convert these waters from marine bays into inland lakes, these marine species were retained within the basins, the waters of which have since been changed, through the agency of springs, into fresh-water; and with the gradual transfer of the water the habits of the animals have also changed gradually, and that without any outward alteration of form. Professor Lovèn thinks that there is sufficient evidence to show that this change in the conditions of these lakes must have taken place during the great glacial period, at a time when the animals now found in

it (and which are known at this day to inhabit only the extreme north) could have lived in the same latitude as the south of Sweden. The evidence of these fresh-water lakes suggests that similar changes in the relative position of sea and land may have been the cause of our having fresh-water Crustacea nearly allied to marine species in our rivers and inland streams."

Higher in the scale of life the inhabitants of salt marshes are few and far between; a few sticklebacks and an occasional gasteropodous mollusc of some common species will almost exhaust the list. We should not, however, pass entirely without mention a very interesting nudibranchiate mollusc, which has been found in a few places. This is *Alderia modesta,* a pretty little species of a greenish colour, living chiefly among the tufts of Vaucheria, upon which it feeds. Where it occurs at all it is mostly in great abundance; but the only British localities hitherto recorded are Lougher Marsh, near Swansea, a marsh near Cork, and Hylton Dene, near Sunderland. Associated with it may sometimes be found a little black slug of the genus *Limapontia.*

Salt marshes such as these, whose inhabitants have been the subjects of our paper, are perhaps the nearest analogues which our islands can now exhibit of those extensive lagoons which, under the fostering influences of an almost tropical climate, supported the dense forests of the Carboniferous period. It has been inferred from certain animal remains found in the coal strata, that those lagoons must have been, in some cases at least, brackish; but considering the widely different aquatic conditions under which it has been shown that the same species may exist, too great caution can scarcely be exercised in the application of any evidence derived from fossil remains.

OPTICAL GHOSTS.

The old mode of obtaining spectral illusions by means of concave mirrors presented many difficulties, which were practically insuperable when the images were required to be on a large scale, and to be comparable in sharpness and apparent density with actual and similar objects seen at the same time. Lately these difficulties have been wonderfully overcome, as the "Patent Ghosts" exhibited at the Polytechnic, and elsewhere, abundantly testify. So great has been the popularity of these exhibitions that, now the mystery is out, and an explanation is offered by Mr. Dircks to the public, the book* purporting to reveal the secret would have been widely welcomed had it

* *The Ghost, as produced in the Spectre Drama,* Popularly Illustrating the Marvellous Optical Illusions, called the Dircksian Phantasmagoria, by Henry Dircks, C.E. *Shaw.*

been better written, and confined to its legitimate subject. Mr. Dircks complains of others, and probably with reason; but about quarrels of this kind the public care little, and when they pay their money for the little book entitled "The Ghost as Produced in the Spectre Drama, by Henry Dircks, Civil Engineer," they do not expect to find nearly all of it devoted to a partially intelligible account of grievances with which they have nothing to do. The amount of explanation given will prove provokingly small, and, to those unacquainted with optics, of little use; while those who are familiar with that science did not want it at all. Mr. Dircks' merit in the patent ghost business appears to consist in the fact that he saw how to utilize the long-known principles involved in the neutral tint reflector, used by microscopists as a substitute for the more expensive *camera lucida*. In this instrument a little plate of thin glass is placed so that the eye looks at it at an angle of 45°, and receives the reflection of the image which the microscope forms of the object on the stage. Thus the eye is affected, not quite so strongly, but just in the same way as if it had looked straight down the microscope tube; and if a piece of white paper is held below the reflector, the object will appear projected upon it, and the eye can, in addition to receiving the reflection, look through the glass and see the hand and pencil by which the outline is traced.

To make this kind of action plainer, let a few simple experiments be performed, and let the reader remember that the angle of incidence is always equal to the angle of reflection, and that objects seen in a looking-glass seem just as far behind it as they are actually before it. If any of our young readers do not distinctly understand the angle of incidence question, they can easily resolve it with marbles or bagatelle balls. Let them place a box, with square sides, on the table, and make a chalk line, so as to form a perpendicular to one of its sides, and falling on the centre. Then, if a marble is bowled against the box so as to strike it slantingly on one side of the perpendicular, it will be thrown back in a similar slant on the other side of the perpendicular. The rays of light behave like the marble or bagatelle ball in this respect.

For our first experiment, take a hand looking-glass, and see your face in it; then incline the bottom of the glass *away* from you till your face is quite ost, and then your body, or hand, if in the way, will appear plainly. You lose sight of the reflection of your face because the angle of the rays from it which fall upon the glass is such that the resulting angle of reflection sends them away from you. You see your body, or hand, because the angle of their incident rays is such that the resulting angle of reflection carries the image straight to your

eyes. Old writers were well aware of the fact that a plane mirror could be so arranged that a person looking at it should not see himself, but see something else, which might be behind a screen, and quite out of his natural view. It is, indeed, very easy to make a looking-glass show you objects quite out of your line of vision, and one of the facets of a moderate-sized diamond will easily enable you to see by reflection any object in a room, when you appear only to be looking at the finger that carries the ring in which it is set.

Having made a few experiments with the looking-glass, take a pane of window glass, or, what is better if you have it, a piece of plate glass, the surface of which is more true, and hold it upright on the table near a window. A few inches in front of it place any small object on the table; a lady's cotton reel will do extremely well. Stand upright with your back to the window, but leave room for the light to fall freely on the top of the reel. Look slantingly down at the glass, and you will see the image of the reel reflected by its surface, and apparently as far behind as it really is before. The top on which the light falls will be brilliant, and the part that is in the shade will be reflected in shadow. Vary the experiment by placing a second reel, exactly like the first, as much behind the glass as the other is placed in front of it. You then have two reels presented to your eye, one actual, and the other spectral, and you can, as Mr. Dircks remarks of a similar case, so arrange the objects, and your position, that the image reflected from the surface of the glass shall exactly correspond with the outlines of the real reel seen *through* the glass. If you put any small article on the top of the reel in front of the glass, or some one else puts a similar object on the top of the reel behind the glass, the optical effects will be the same.

Now make a third experiment. Put a box, or thick book, in front of you, so that you cannot see the reel, when placed on the table just under its edge. Then hold the glass a little way off, and upright as before, so that you see it from top to bottom. You may then obtain a reflected image of the reel, which the book conceals, and if a strong light were thrown upon it, the image would be as sharp, distinct, and apparently solid as the reality.

Thus this kind of optical ghost is very easily made, and Mr. Dircks suggests a few effective tricks. We have not dwelt at any length upon verbal explanations, because everybody can make the simple experiments suggested, and they will explain the matter much better than a lengthened essay could effect. We ought, however, to add, that Messrs. Horne and Thornthwaite supply a portable apparatus, by which the Dircksian ghosts can be easily and strikingly shown.

Mr. J. H. Brown, acting upon another set of optical principles, offers us "Ghost's Everywhere, and of any Colour."* We need not stay to comment on the explanatory part of this volume, but proceed to the pictures, which are drawn and coloured so as to excite similar images on the retina in accidental colours. Our readers have no doubt often tried the experiment of sticking coloured wafers on a sheet of white paper, holding them a strong light, and staring at them fixedly for a few seconds. If this is done, and the eye then taken off the wafer, and turned on to the white paper, the wafers' image will appear sharp and distinct, but in another colour. A red wafer will look green (or blue and yellow combined), a blue one orange (or red and yellow combined), a yellow one purple (or blue and red combined), and wafers of composite hues will be affected in an analogous way. These "spectral," "accidental," or "complementary" colours—for they are known under these three appellations—appear bright to the eye in proportion to its sensitiveness to the original colour, to the strength of the illumination, and to the steadiness with which the original object has been contemplated. Mr. Brown finds the time occupied in counting twenty, or about a quarter of a minute, sufficient to impress his figures upon most eyes, if the plates are well lit up. His directions are to look steadily, for the time specified, at a dot or asterisk to be found in each plate, "the plate being well illuminated by either artificial or day light. Then turning the eyes to the ceiling, the wall, or the sky, or, better still, to a white sheet hung on the wall of a darkened room (not totally dark), and looking rather steadily at one point, the spectre will soon begin to make its appearance, increasing in intensity, and then gradually vanishing, to reappear and again vanish."

The Brownian spectres depend upon the tendency of strong impressions to remain a little while upon the eye, and to reappear in accidental colours. The plates are certainly very effective, and well designed for the purpose; but we should recommend an avoidance of needless horrors in future series. The grotesque and the beautiful will both work just as vividly as the ghastly, and several objects in the present series could not be judiciously introduced to the notice of boys and girls whose disposition was nervous, or whose superstitious feelings had been excited by injudicious nursery tales.

Mr. Brown's direction to enlarge the spectral appearance by looking for it on a white sheet, or wall, some distance

* *Spectropia, or Surprising Spectral Illusions*, showing Ghosts Everywhere and of any Colour, by J. H. Brown. First series, with sixteen illustrations *Griffiths and Co.*

off, is very ingenious, and brings us back to the microscopic neutral tint reflector with which we started. This reflector enables drawings to be made much larger than the actual image which the microscope transmits to the eye. Suppose, for example, the image represented an insect one inch long, and the draughtsman tried to sketch it with a long pencil on a sheet of paper placed on the floor, he would have to make a picture on the floor as big as an object must be to equal in apparent size a far smaller object nearer the eye. This may be made plain by a diagram, and plainer by an experiment. Take, for example, a sixpence, and hold it at such a distance from the eye that its diameter exactly equals that of a large picture across the room. Then the sixpence, at so many inches, and fractions of an inch, from the eye, looks as broad as the great picture so many feet off. For a second illustration, hold the sixpence steadily in front of the eye, about six or eight inches off, and let some one else stand by the wall and make a mark corresponding with the circular space the sixpence hides. In this case the great circle, so many feet or yards off, is equivalent to the little sixpence at six or eight inches off. In the instance of the image reflected by the neutral tint glass used with the microscope the pencil was employed to trace out an outline that would be equivalent to the reflected image seen much closer, and in Mr. Brown's enlarged ghosts, the optical image takes the size of his plates, as they appear at a convenient distance from the eye, but they *seem* as big as they would look if drawn on a larger scale on the wall on which they are *fancied* to appear.

THE RUINS OF COPAN.

In our number for May, 1863, we gave a beautiful view of an enormous sculptured monolith from the pre-incarial ruins of Tia Huanaco in Bolivia, formerly Upper Peru, accompanied by a paper, in which Mr. Bollaert collected together the very little that is known concerning this kind of work. The whole subject of American antiquities is under a dense cloud. We can only make rude guesses concerning the dates of the remarkable remains, or of the extinct and forgotten people by whom they were executed. It is however of importance that accurate representations should be preserved of the principal objects of interest, and for this purpose photography is of great value, and fortunately admits of reproduction at a very moderate price. The Tia Huanaco ruins form a portion of numerous works, extending over a considerable geographical area, and all bearing evidence of having

been produced under similar conditions of knowledge, sentiment, and skill. They certainly could not have belonged to a barbarous age, because they evince a considerable command of mechanical powers, and show an advanced though highly conventional style of art.

Messrs. Smith, Beck, and Beck have recently made a valuable addition to the means of study at the disposal of archæologists, by publishing a highly interesting series of stereoscopic slides, from photographs taken by Mr. Albert Salvin, of the ruins of Copan, Honduras. They comprise richly sculptured stones, that no doubt formed portions of considerable buildings, bearing in their hieroglyphic ornamentation a strong likeness to our Tia Huanaco plate. A careful inspection of the series will show that the artistic skill possessed by the unknown workers in an unknown age was very considerable; and we cannot doubt that some system of mythology, and some facts of curious history lie hid in allegorical representations, which we have no key to unlock.

Mr. Salvin's series of slides are well worth study, and though we are not disposed to waste time in mere conjectures, we cannot relinquish the hope that the clue to this American mystery may yet be found out. We shall not attempt a detailed description of these remarkable objects; but they all belong to the Tia Huanaco type; and we agree with Mr. Salvin in considering that they were associated with the mythology of the people by whom they were wrought. The stone in which they are executed, is a close-grain porphyry, and the preservation of the sculpture has enabled the photographic apparatus to produce excellent and highly interesting copies, on which the labours of the archæologist may not be exerted in vain.

No. 7 of the series represents a very remarkable monolith, 12 feet high. A face, powerfully sculptured upon it, looks much more like a portrait than a conventional figure; the features bear some resemblance to the Mongolian type. No. 20 is an admirable, though conventional, jaguar's head, equalling in force of expression any analogous European work. No. 13 is a circular stone, supposed to be sacrificial. It has a rounded surface, and a border of twisted or cable pattern. There are in all twenty-four slides, accompanied by a descriptive pamphlet.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1863. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Oct. 1	29·250	54·1	52·6	·95	·408	57·5	50·7	6·8	8, 7, 7	SW, W, W by S.	·379
„ 2	29·788	51·7	49·0	·91	·361	55·5	48·2	7·3	10, 10, 10	SW by W, SW, SW.	·148
„ 3	29·877	56·9	55·7	·96	·453	59·8	50·9	8·9	10, 10, 10	SW, SW by S, SW by S.	·050
„ 4	...	...	...	...	...	63·4	57·5	5·9	...	... ...	·005
„ 5	29·952	48·6	47·0	·95	·337	55·3	37·6	17·7	7, 10, 10	WSW, S, SSE.	·005
„ 6	29·946	46·5	37·3	·73	·240	52·2	37·2	15·0	0, 4, 9	NW by W, NE, ESE.	·017
„ 7	29·660	53·3	51·7	·95	·395	58·1	40·3	17·8	10, 10, 10	E by S, E by N, E.	·011
„ 8	29·550	57·7	54·6	·90	·436	63·3	53·6	9·7	5, 3, 10	E, E, E.	·293
„ 9	29·558	51·4	44·8	·80	·312	56·8	49·3	7·5	10, 3, 1	E, S by E, SE by S.	·006
„ 10	29·649	57·3	48·9	·75	·359	61·3	46·8	14·5	9, 10, 9	S by E, SE, ESE.	·000
„ 11	...	...	...	...	...	59·5	52·2	7·3	...	... ...	·034
„ 12	29·445	53·3	50·3	·90	·377	58·0	47·6	10·4	6, 3, 1	S, SE, SE by E.	·003
„ 13	29·326	52·2	48·5	·88	·354	57·7	49·4	8·3	10, 9, 1	S, SSW, S by W.	·035
„ 14	29·630	55·9	50·4	·83	·378	61·1	50·0	11·1	6, 7, 2	S by E, S, S.	·130
„ 15	29·576	52·9	53·0	1·00	·413	57·8	49·0	8·8	10, 10, 10	—, —, —.	·026
„ 16	29·859	53·0	49·7	·89	·369	58·1	48·6	9·5	3, 4, 5	SW, SW, SW by S.	·124
„ 17	30·005	53·8	46·5	·78	·331	58·7	48·2	10·5	6, 2, 7	W, WSW, —.	·009
„ 18	...	...	...	...	...	59·0	43·0	16·0	...	... ...	·004
„ 19	30·065	55·5	54·3	·96	·432	59·7	54·7	5·0	10, 10, 10	SW, SW, SW.	·000
„ 20	30·064	53·4	52·9	·98	·412	58·1	53·2	4·9	10, 10, 10	SW by S, NNW, —.	·008
„ 21	30·132	54·1	52·9	·96	·412	60·1	50·2	9·9	10, 7, 7	—, —, —.	·010
„ 22	30·117	55·2	51·1	·87	·387	61·2	51·0	10·2	10, 5, 4	SW by W, WSW, —.	·005
„ 23	30·248	49·5	44·1	·83	·305	55·6	42·6	13·0	1, 1, 2	WNW, NW, —.	·003
„ 24	30·200	44·8	44·6	·99	·310	55·5	32·9	22·6	10, 10, 10	—, E, —.	·000
„ 25	...	...	...	...	...	53·7	33·5	20·2	...	... ...	·000
„ 26	30·020	45·7	43·8	·94	·302	52·3	37·6	14·7	7, 9, 10	—, NE by E, NE.	·000
„ 27	29·920	44·2	41·6	·91	·279	49·4	34·6	14·8	10, 9, 10	—, —, —.	·000
„ 28	29·631	47·9	47·0	·97	·337	54·3	41·5	12·8	6, 10, 2	S by W, SW by S, SW.	·000
„ 29	29·308	49·0	44·9	·87	·313	54·3	42·2	12·1	10, 10, 2	S by W, S by W, SW.	·118
„ 30	29·200	46·1	43·9	·92	·302	53·5	42·8	10·7	10, 10, 2	S by E, S, W.	·146
„ 31	29·499	45·8	34·0	·66	·214	50·8	39·8	11·0	1, 3, 0	SW by W, SW, SW by S	·469
Monthly Means.	29·758	51·5	48·0	·89	·353	...	...	11·4	...	...	2·038

To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—Oct. 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	17	8	12	20	4	6	6	19	2	18	12	6		11	7	6	11	1	21	10	7	4	1	1	8	1	4	1	8	17	19	8·8
A.M. 1	15	10	14	26	1	3	9	13	3	19	10	7		8	7	10	10	2	19	12	7	5	1	1	9	0	2	1	2	15	18	8·6
2	12	12	13	24	2	4	12	13	2	19	15	7	306	11	6	9	10	1	23	15	10	5	5	2	11	0	0	0	2	15	16	9·2
3	12	14	15	18	4	3	17	9	4	16	15	6		14	5	10	13	4	18	14	4	6	2	1	14	0	1	0	4	11	18	9·1
4	10	12	15	17	2	2	14	11	6	15	20	4		11	6	13	15	6	14	19	5	6	2	0	9	1	0	0	5	12	20	9·1
5	14	11	18	20	1	2	11	14	3	21	16	6		9	5	13	13	4	14	13	7	5	1	2	8	1	1	0	9	12	23	9·2
6	10	10	19	23	0	2	15	18	2	18	19	5		10	7	15	13	5	13	10	8	6	3	2	8	1	0	2	10	17	28	10·0
7	16	9	27	27	1	2	15	21	4	17	20	8		10	6	19	10	8	16	11	10	4	2	3	8	1	1	4	14	20	27	11·4
8	18	8	24	20	1	4	15	21	5	18	25	10		15	2	15	11	11	17	12	10	5	3	1	10	1	0	7	11	21	27	11·6
9	16	13	26	24	5	5	17	25	6	19	21	11		16	2	16	13	15	14	10	5	8	3	2	15	0	1	9	9	24	28	12·7
10	18	14	27	24	10	3	15	22	6	19	18	16	15	15	8	15	13	19	16	10	3	10	10	1	20	4	1	11	19	25	28	14·0
11	18	12	23	19	10	5	18	19	6	17	17	16	15	21	4	16	10	19	19	8	3	8	6	2	18	7	1	12	20	28	33	13·9
12	15	18	26	19	10	4	24	20	8	18	17		11	24	1	15	9	18	18	7	2	7	8	5	16	3	2	11	27	23	32	13·6
P.M. 1	3	14	25	15	8	2	26	27	13	16	16		14	21	2	13	11	17	15	7	3	6	6	5	16	1	1	7	28	28	31	13·2
2	12	13	22	9	8	4	27	28	10	17	18		21	19	0	14	9	19	18	4	1	6	5	5	15	1	2	5	26	22	29	13·3
3	11	10	22	7	8	6	23	32	9	18	13		16	14	1	15	6	18	17	2	1	6	3	4	11	2	3	4	24	30	28	12·1
4	10	11	25	4	6	5	23	31	8	16	9		12	12	7	12	2	19	20	2	1	2	2	1	12	5	1	5	24	24	25	11·2
5	6	10	23	5	5	2	26	27	6	13	5		12	13	5	10	2	15	14	1	1	1	3	2	12	2	2	4	19	18	22	9·5
6	4	12	22	4	5	1	23	25	9	11	5		9	8	7	6	1	18	18	2	1	0	1	2	5	3	0	2	15	17	23	8·6
7	6	11	25	3	4	5	19	23	15	15	8		8	10	8	8	2	19	18	5	2	1	1	6	2	5	1	4	18	21	24	9·9
8	8	11	25	4	3	6	13	17	13	20	6		5	9	5	9	2	22	13	3	5	1	1	7	5	1	2	1	20	19	18	9·1
9	5	14	21	2	6	6	13	11	12	15	8		7	10	7	7	2	23	21	3	4	2	0	6	2	0	1	3	22	20	22	9·2
10	8	10	29	2	7	5	14	4	18	19	8		5	12	10	6	1	25	16	6	5	2	1	7	1	1	2	1	18	20	21	9·5
11	9	11	25	2	5	5	12	5	15	14	8		6	6	9	9	2	20	11	3	8	1	1	9	1	1	2	0	16	19	21	8·4
12																																
Total Daily Movement.	273	278	523	338	116	92	407	155	185	408	382	564		309	127	281	191	328	408	189	108	107	71	77	236	42	81	94	365	478	581	10·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 3·30 P.M., and 9 P.M. respectively.		
Day of Month.	Barometer, corrected to Temp. 32°*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Nov. 1	...	...	...	...	...	48·5	37·8	10·7			·003
„ 2	28·998	43·9	39·5	·86	·260	48·4	39·6	8·8	8, 10, 9	SW by W, SW by W, WSW.	·777
„ 3	29·761	47·8	44·6	·89	·310	52·5	37·8	14·7	10, 10, 10	SW, SW, SW.	·056
„ 4	30·002	56·0	50·4	·83	·378	59·4	42·8	16·6	10, 10, 10	SW by W, WSW, SW by S.	·151
„ 5	30·161	54·9	50·5	·86	·380	57·6	52·8	4·8	10, 10, 10	SW by W, SW by W, SW.	·121
„ 6	30·481	41·9	36·1	·82	·230	45·1	37·3	7·8	5, 5, 4	NE by E, ESE, —.	·044
„ 7	30·155	48·8	48·3	·98	·352	53·4	34·7	18·7	10, 10, 10	S by W, SW by W, W.	·000
„ 8	...	...	...	...	...	52·1	45·4	6·7	...	... ...	·127
„ 9	30·228	43·5	31·9	·67	·198	47·7	41·2	6·5	1, 4, 9	NE, NE by E, NE.	·151
„ 10	29·753	41·0	37·3	·88	·240	45·7	24·4	21·3	10, 7, 3	SW, SW, W by N.	·030
„ 11	29·376	38·5	35·8	·91	·228	43·0	29·9	13·1	10, 9, 2	NE by E, NE by N, N by W.	·014
„ 12	29·939	39·9	34·4	·82	·217	44·7	30·4	14·3	0, 2, 6	N by E, N, N by W.	·022
„ 13	30·269	41·1	37·2	·87	·239	47·0	28·1	18·9	9, 10, 10	SW by W, SSW, SW by S.	·000
„ 14	30·262	47·1	44·7	·92	·311	49·9	28·1	21·8	10, 10, 10	SW, WSW, W by S.	·024
„ 15	...	...	...	...	...	52·4	28·1	24·3	...	... ...	·000
„ 16	30·144	50·7	49·4	·96	·366	54·6	46·0	8·6	10, 10, 4	SW, SW, SW.	·002
„ 17	30·155	49·9	45·0	·84	·314	53·3	47·9	5·4	10, 10, 10	W, W by S, SW.	·000
„ 18	30·234	47·7	43·3	·86	·296	50·0	46·9	3·1	8, 9, 10	S, S, S by W.	·000
„ 19	30·194	46·8	43·0	·88	·293	50·0	43·7	6·3	9, 10, 10	—, SW, SW.	·000
„ 20	30·119	46·7	43·6	·90	·299	50·7	42·2	8·5	10, 3, 1	SSW, S, S.	·000
„ 21	29·678	50·7	48·0	·91	·348	56·3	38·2	18·1	4, 6, 10	SSE, S, S.	·000
„ 22	...	...	...	...	...	50·5	41·2	9·3	...	... ...	·170
„ 23	29·856	48·0	45·0	·90	·314	52·1	41·7	10·4	1, 10, 10	SW, SW by S, SW.	·022
„ 24	29·870	52·4	52·1	·99	·401	55·0	44·5	10·5	10, 10, 10	S, SW, SW by W.	·158
„ 25	30·075	52·2	49·9	·92	·372	55·8	50·6	5·2	9, 7, 10	SSE, S by E, S by E.	·026
„ 26	30·348	49·6	48·6	·97	·356	55·8	44·1	11·7	10, 10, 10	SE, SE by E, SE.	·006
„ 27	30·338	46·6	43·9	·91	·302	49·5	46·2	3·3	10, 7, 10	SE, SE, ESE.	·000
„ 28	30·293	42·6	38·1	·85	·247	46·0	42·9	3·1	9, 3, 3	SE, ESE, SE by E.	·000
„ 29	...	...	...	...	...	44·6	28·8	15·8	...	... ...	·000
„ 30	30·117	36·5	35·2	·95	·223	40·2	28·1	12·1	10, 7, 5	E, NNE, NNE.	·015
Monthly Means.	30·032	46·6	43·0	·89	·299	...	...	11·3	...	... ...	1·919

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—NOVEMBER, 1863.

Hour. \ Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A.M. 12–1	19	18	24	20	19	2	3	7	24	8		5	5	5	4
1–2	20	30	23	24	15	4	1	9	21	2		4	2	5	4
2–3	15	25	20	25	15	7	2	11	20	2		5	3	4	4
3–4	15	20	14	24	14	5	2	8	20	3		6	4	6	5
4–5	13	18	17	25	16	11	5	9	22	0	108	5	3	8	5
5–6	14	16	13	21	15	7	3	9	17	1		4	4	7	5
6–7	13	12	10	19	15	7	4	13	19	0		4	3	5	5
7–8	13	14	7	22	14	7	6	15	19	1		3	2	4	5
8–9	12	10	13	19	17	8	4	14	18	3		4	4	6	4
9–10	17	15	14	21	16	10	5	13	17	7		5	4	5	5
10–11	22	15	13	23	19	10	7	10	23	13	8	13	5	7	7
11–12	24	15	11	20	19	7	7	10	21	12	10	15	9	5	7
P.M. 12–1	20	20	16	22	22	6	11	17	23	10	12	13	11	3	7
1–2	19	16	15	22	20	3	9	16	20	7	10	13	8	5	11
2–3	20	14	19	18	23	4	6	17	19	3	9	13	8	4	8
3–4	17	17	20	19	22	2	7	18	12	7	9	9	7	6	5
4–5	12	18	18	23	20	1	7	21	9	8	9	6	7	4	6
5–6	9	19	17	26	19	1	9	17	5		6	5	7	2	7
6–7	6	22	16	25	18	1	7	17	4		5	4	7	2	7
7–8	7	34	16	26	14	0	6	22	2		4	4	6	2	9
8–9	11	35	16	25	15	1	9	28	8		6	5	5	3	6
9–10	14	30	18	26	9	0	9	25	8		6	7	5	5	5
10–11	15	22	20	25	5	0	9	25	4		3	4	5	8	5
11–12	22	22	19	21	2	1	7	20	1		3	2	3	7	6
Total Daily Movement.	369	477	389	541	388	105	145	371	346	290		158	127	118	142

Hour. \ Day.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
A.M. 12–1	9	12	4	8	1	5	20	9	9	11	4	11	6	7		9·8
1–2	8	11	9	9	3	10	20	9	7	7	2	7	6	7		10·0
2–3	13	14	12	8	4	11	18	9	8	7	4	8	6	8		10·3
3–4	11	14	9	4	4	11	18	5	7	7	2	9	5	3		9·0
4–5	8	14	10	6	2	4	19	5	5	8	2	10	7	7		9·4
5–6	9	13	12	5	6	9	18	5	5	8	4	10	7	10	187	9·2
6–7	9	15	10	8	10	15	15	7	5	7	9	7	5	5		9·0
7–8	12	14	12	1	9	11	15	7	7	10	8	8	7	6		9·3
8–9	10	14	5	4	8	13	13	3	9	10	7	8	6	2		8·8
9–10	9	16	6	1	8	16	17	8	7	11	8	10	9	2		10·1
10–11	15	19	13	6	10	20	22	11	9	15	12	10	11	3		12·8
11–12	12	16	8	6	10	23	19	14	11	11	11	8	8	3		12·1
P.M. 12–1	10	19	16	8	10	21	21	13	13	17	12	7	8	14		13·8
1–2	11	19	16	10	5	23	20	14	8	12	10	8	8	20		13·0
2–3	9	16	13	5	6	27	19	12	9	12	8	5	6			11·9
3–4	8	12	14	8	5	31	13	12	11	14	10	6	4			11·6
4–5	6	12	11	5	7	38	12	14	11	12	9	2	6		61	11·2
5–6	4	10	12	7	5	27	13	10	9	10	9	5	5			10·2
6–7	5	12	10	8	2	28	13	9	8	12	10	6	4			9·9
7–8	8	11	12	9	4	25	12	6	9	10	12	10	10			10·7
8–9	10	9	10	3	5	22	12	8	9	7	12	9	3			10·6
9–10	11	10	12	5	2	18	11	7	9	13	15	7	3			10·6
10–11	11	7	13	9	4	20	8	5	12	8	14	9	7			10·3
11–12	10	5	5	4	3	17	9	9	10	7	9	7	8			8·8
Total Daily Movement.	228	314	254	142	133	445	377	211	207	246	203	187	146	345		10·8

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Dec. 1	29·696	47·2	46·3	·97	·329	51·1	28·6	22·5	10, 10, 10	SSE, S, S by W.	·006
„ 2	29·122	47·7	42·1	·82	·284	54·1	43·0	11·1	7, 10, 1	S, WNW, W by N.	·211
„ 3	29·329	43·3	27·7	·58	·171	47·7	37·6	10·1	9, 3, 3	W, SW, W by S.	·675
„ 4	30·358	41·4	35·3	·81	·224	47·1	33·2	13·9	0, 10, 10	WSW, SW, S by W.	·006
„ 5	30·105	49·0	43·4	·82	·297	51·3	36·9	14·4	10, 10, 10	SW, SW, SW.	·000
„ 6	...	...	...	...	...	48·2	38·6	9·6	...	... ...	·063
„ 7	30·365	48·9	43·7	·83	·300	51·0	40·1	10·9	9, 10, 10	SW, SW by W, SW.	·000
„ 8	30·093	48·2	41·8	·80	·281	49·7	45·1	4·6	10, 10, 7	SW, SW, WSW.	·003
„ 9	30·038	47·9	47·0	·97	·337	51·2	45·5	5·7	10, 10, 10	SW, WNW, W.	·056
„ 10	30·225	43·0	39·4	·88	·259	46·7	34·0	12·7	0, 6, 8	SW, SW, SW by W.	·035
„ 11	30·125	48·9	42·8	·81	·291	51·2	38·5	12·7	10, 10, 10	WSW, W, W by S.	·005
„ 12	30·128	51·3	46·7	·85	·333	53·7	46·7	7·0	3, 2, 10	W by N, W by S, W.	·002
„ 13	...	...	...	...	...	48·4	36·4	12·0	...	... ...	.000
„ 14	30·430	43·2	40·0	·90	·264	50·0	37·9	12·1	10, 2, 1	SSW, W by S, W by S.	·005
„ 15	30·322	44·9	43·0	·93	·293	46·7	33·3	13·4	10, 10, 10	SW, SW, SW by S.	·000
„ 16	29·824	43·8	37·2	·79	·239	49·2	43·2	6·0	10, 8, 7	SW, WSW, W.	·000
„ 17	30·042	43·4	32·3	·68	·201	45·1	37·5	7·6	10, 10, 4	NW by N, NW by N, N.	·003
„ 18	30·484	36·9	29·9	·78	·185	40·9	31·7	9·2	5, 0, 7	NNW, NW, W.	·002
„ 19	30·466	44·6	40·2	·86	·266	48·2	33·4	14·8	10, 10, 10	SW, NW, W.	·000
„ 20	...	...	...	...	...	43·7	31·8	11·9	...	... ...	·000
„ 21	30·104	44·0	39·5	·85	·260	49·1	36·6	12·5	9, 10, 10	—, WSW, W by S.	·007
„ 22	30·045	35·7	22·0	·61	·140	40·5	39·8	0·7	10, 0, 0	NNE, NNW, NW.	·030
„ 23	30·016	44·0	38·4	·82	·250	48·6	26·4	22·2	10, 2, 1	SW, W by S, W by S.	·000
„ 24	30·228	44·8	40·3	·86	·267	48·1	38·5	9·6	10, 6, 10	WSW, W, W.	·000
„ 25	...	...	...	...	...	48·4	41·7	6·7	...	... ...	·000
„ 26	29·964	49·4	47·3	·93	·340	51·4	40·9	10·5	10, 10, 10	SW by W, SW by S, SW.	·002
„ 27	...	...	...	...	...	42·6	41·3	1·3	...	... ...	·002
„ 28	30·277	35·2	32·4	·90	·202	...	28·4	...	10, 10, 10	E by N, SE by E, ESE.	·000
„ 29	29·907	49·5	42·8	·79	·291	52·0	...	...	10, 10, 10	SW, W, W by S.	·003
„ 30	30·120	41·7	36·9	·85	·237	44·5	39·5	5·0	3, 1, 0	W by S, W by N, NW by W.	·000
„ 31	29·779	37·0	34·7	·92	·219	39·9	26·4	13·5	10, 10, 10	E, ESE, E by S.	·005
Monthly Means.	30·061	44·4	39·0	·83	·260	...	...	10·5	...	... ...	1·121

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—DECEMBER, 1863.

	Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
A.M.	12 to 1		23	12	15	14	8	12	30	24	5	12	17	11	4	3	13	15	12	6	2	10	15	8	10	7	15	18	8	7	8	1	11·3
	2		25	13	9	18	7	14	11	20	6	11	16	5	5	2	13	15	12	6	2	10	22	6	10	5	14	20	1	11	9	4	10·7
	3		18	15	15	19	7	11	22	18	6	10	17	5	4	1	16	19	12	4	2	9	19	6	11	5	12	18	2	10	9	2	10·8
	4		27	20	16	17	9	13	20	20	5	11	17	4	5	2	15	17	11	4	3	9	21	9	6	8	13	17	2	10	12	6	11·6
	5		24	24	11	17	9	14	21	18	8	10	21	5	4	3	18	16	11	5	3	7	20	10	7	9	18	17	1	14	9	5	12·0
	6	87	25	30	12	18	5	13	20	17	6	8	15	2	4	2	19	14	9	4	3	6	18	12	6	7	16	15	0	13	11	13	11·4
	7		21		12	20	5	14	19	15	5	10	18	4	2	4	19	18	11	6	2	8	17	13	6	9	20	13	1	11	9	12	11·2
	8		23		11	21	5	15	19	17	4	12	17	4	4	5	17	19	12	4	4	4	20	14	9	10	18	16	1	11	9	15	11·7
	9		16	152	9	21	5	16	21	14	5	12	17	3	3	5	17	17	10	6	3	2	20	14	7	8	20	12	0	15	4	15	10·9
	10		14		13	19	8	17	23	13	9	10	18	3	2	5	19	23	9	5	6	4	26	16	4	9	18	12	2	17	8	12	11·8
	11	18	14	38	13	23	10	16	21	12	10	14	21	5	6	4	21	20	10	5	10	3	20	16	5	9	19	16	4	21	8	16	13·8
	12	20	12	40	11	24	12	18	20	9	12	16	22	8	6	5	21	23	10	6	8	3	23	17	7	10	18	14	2	23	6	20	14·4
P.M.	1	21	11	39	12	27	11	22	20	12	15	18	22	8	8	5	23	23	9	11	14	4	19	18	10	13	16	14	5	19	8	19	15·4
	2	22	13	38	10	25	16	12	25	9	14	22	19	8	8	5	21	22	7	11	11	8	23	16	8	11	15	12	5	23	8	23	15·0
	3	22	30	39	9	23	11	18	20	4	13	23	21	7	9	5	17	20	4	7	11	8	15	19	6	9	14	11	7	27	10	21	14·8
	4	22	38	33	10	21	7	18	21	4	14	22	16	7	6	4	14	22	2	6	10	11	7	20	6	11	15	11	4	22	7	21	13·9
	5	26	32	40	12	22	7	16	19	7	14	20	14	2	4	5	13	20	3	5	8	12	6	19	7	9	14	8	3	16	5	21	13·2
	6	23	26	35	14	19	8	16	16	5	13	17	14	7	3	7	14	20	5	4	8	6	7	18	4	13	13	5	4	20	3	22	12·5
	7	23	21	35	15	19	12	16	16	4	12	20	16	6	6	6	14	20	4	5	4	8	6	21	7	11	16	4	4	18	3	25	12·8
	8	21	17	30	17	17	14	14	14	7	13	16	11	5	3	7	14	18	8	3	7	10	9	16	9	12	17	5	7	17	2	27	12·5
	9	15	12	32	17	15	10	13	14	8	14	20	10	7	3	10	14	17	6	2	8	9	6	12	4	12	16	4	8	13	2	25	11·4
	10	9	12	25	18	15	12	15	16	5	13	22	7	5	3	9	12	15	3	3	7	9	6	8	6	14	19	4	11	13	2	25	11·1
	11	11	11	31	17	10	13	16	19	7	17	26	8	6	3	13	15	17	4	5	10	11	4	11	5	13	13	2	14	11	1	26	11·9
	12	22	14	27	18	5	11	20	21	5	11	24	14	7	2	13	14	16	5	1	9	11	5	9	5	14	14	1	10	8	4	25	11·8
Total Daily Movement.		362	479	748	316	449	222	369	468	269	244	386	388	134	107	180	393	446	189	124	155	177	354	328	165	238	383	269	101	370	157	401	12·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

MONTHLY AND ANNUAL MEANS FOR THE YEAR 1863.

Month.	Barometer, corrected to temp. 32.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Daily Range.	Total Fall of Rain.	Month.	Barometer, corrected to temp. 32.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Daily Range.	Total fall of Rain.
	inches.	°			inch.	°	inches.		inches.	°	°		inch.	°	inches.
January	29·765	42·5	37·4	·84	·244	9·5	2·488	August ...	29·868	61·2	51·8	·74	·402	16·2	1·755
February ...	30·306	43·1	37·4	·83	·244	12·6	0·514	September.	29·818	53·2	45·5	·77	·323	15·9	2·818
March.........	29·879	45·3	36·2	·74	·235	15·3	0·683	October ...	29·758	51·5	48·0	·89	·353	11·4	2·038
April	29·934	48·8	38·9	·74	·259	17·1	0·801	November.	30·032	46·6	43·0	·89	·299	11·3	1·919
May...........	30·002	51·6	41·8	·72	·287	17·1	1·393	December..	30·061	44·4	39·0	·83	·260	10·5	1·121
June	29·863	56·6	47·8	·75	·350	16·6	4·167								
July............	30·077	62·1	48·9	·65	·364	21·1	0·757	Mean	29·947	50·5	43·0	·78	·302	14·5	19·954

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

TABLE SHOWING THE MEAN VELOCITY OF THE WIND FOR EACH HOUR OF THE DAY IN THE DIFFERENT MONTHS OF THE YEAR 1863 (IN MILES PER HOUR).

	A. M.												P. M.												
Hour.	12 to 1	to 2	to 3	to 4	to 5	to 6	to 7	to 8	to 9	to 10	to 11	to 12	to 1	to 2	to 3	to 4	to 5	to 6	to 7	to 8	to 9	to 10	to 11	to 12	Mean.
Jan.	17·1	16·7	17·2	18·0	17·4	17·0	17·4	17·7	17·3	17·0	17·6	17·1	18·5	18·2	17·5	15·7	16·0	14·7	15·0	15·1	15·3	15·3	16·7	15·6	16·8
Feb.......	8·8	8·7	8·0	7·7	8·2	8·5	8·7	8·7	8·5	10·0	11·6	12·2	13·2	13·7	13·0	11·9	11·2	9·7	9·8	10·1	9·6	9·2	9·9	8·9	10·0
March ...	7·8	8·1	8·1	8·1	8·6	7·3	8·7	9·4	10·1	11·4	13·1	14·1	14·4	15·0	14·4	14·3	13·1	10·6	9·4	9·1	8·0	8·7	8·5	7·5	10·6
April.	8·2	7·6	6·9	7·1	6·8	7·4	8·3	10·8	12·2	13·4	13·6	15·0	15·7	15·9	15·7	15·2	14·7	13·7	11·1	10·1	9·0	8·4	7·6	7·5	10·9
May.......	8·1	7·5	7·6	7·6	7·8	7·4	9·3	12·2	12·6	12·5	13·8	15·0	15·5	16·1	15·4	15·3	15·3	13·7	12·4	10·8	9·5	9·7	10·2	8·4	11·4
June......	8·3	7·2	7·1	6·5	7·1	7·6	8·4	9·3	10·5	10·8	11·5	12·6	13·5	14·0	13·3	12·6	13·4	12·0	11·3	9·9	8·4	8·3	8·8	8·1	9·9
July	4·8	4·1	4·2	4·3	4·4	5·1	6·3	7·6	8·9	9·8	10·5	10·5	10·3	10·1	10·1	9·9	10·5	9·3	8·3	7·5	6·9	6·5	6·2	5·0	7·5
August...	7·3	7·4	7·3	6·8	7·6	7·6	9·5	11·6	12·7	13·7	14·9	15·7	16·0	16·1	15·5	15·2	14·3	13·3	13·1	10·1	8·6	8·2	8·9	7·4	11·5
Sept.	7·3	7·2	7·1	6·7	6·8	6·7	6·8	8·9	10·6	12·3	13·3	13·5	14·5	14·0	13·5	13·1	11·7	10·3	9·2	9·3	9·0	8·1	8·3	7·7	9·8
Oct.	8·8	8·6	9·2	9·1	9·1	9·2	10·0	11·4	11·6	12·7	14·0	13·9	13·6	13·2	13·3	12·1	11·2	9·5	8·6	9·9	9·1	9·2	9·5	8·4	10·7
Nov.......	9·8	10·0	10·3	9·0	9·4	9·2	9·0	9·3	8·8	10·1	12·8	12·1	13·8	13·0	11·9	11·6	11·2	10·2	9·9	10·7	10·6	10·6	10·3	8·8	10·3
Dec.	11·3	10·7	10·8	11·6	12·0	11·4	11·2	11·7	10·9	11·8	13·8	14·4	15·4	15·0	14·8	13·9	13·2	12·5	12·8	12·5	11·4	11·1	11·9	11·8	12·5
Mean.....	9·0	8·6	8·6	8·5	8·8	8·7	9·5	10·7	11·2	12·1	13·4	13·9	14·5	14·5	14·0	13·4	13·0	11·6	10·9	10·4	9·6	9·4	9·7	8·8	11·0

WE NEVER SEE THE STARS.

Take a man out into the fields on a calm, quiet night, when the moon is absent, the air clear, and as he looks upward, the "floor of heaven" seems "inlaid with patines of bright gold." Let him see Vega beaming with steady lustre, like a benevolent sapphire eye keeping watch over the world; Capella fitfully flashing; the Bear careering round the silent pole; Orion with his diamond belt; and Sirius blazing in such splendour as to vindicate his title as "the leader of the host of heaven," and leave no wonder that the old Egyptians worshipped him as a sacred orb, and formed the sloping sides of their pyramids that his beams should fall straight and full upon them when he reached his highest point in the skies that over-arched their wondrous land. Let our observer gaze steadily as the smaller stars come out from their homes in the deep unfathomable blue, until, between what the eye sees, and what the mind imagines, the broad fields of space are all alive with light, and, from every point of the compass, stars innumerable seem to gleam. When the eye has thus been filled with brightness, we could scarcely make a more startling assertion than is conveyed in the words, "we never see the stars," and yet no statement can be more true. What then, do we see? The answer is, we see certain rays of light which, in popular phraseology, *left* the celestial orbs some time ago: years ago we know in some instances, centuries perhaps in others, and thousands of years, it may be, in still other cases, and possibly millions might be required to state the time at which, in the remote past, that force was exercised, or vibration excited, by which we recognize the existence of the most distant of those suns whose beams are able to affect our sight. The nearest star is, however, too far off for his light-rays to bring to us a picture of his face. In the moon we see, with the unaided eye, certain indications of the form and character of the surface of our satellite. In the planets, minute discs, in which all features have vanished, proclaim by the low power that makes them distinctly visible, comparative nearness to ourselves; but of the stars another story must be told. They are not like the moon, partly decipherable by the unassisted eye; not like the planets, surrendering more or less of the secret of their form to the glasses of the telescope—they defy alike the eye of the mortal, and the grandest optical machinery which he has been able to invent. They do indeed, in fine weather, look like small regular discs in a telescope, but increasing the power of the eye-piece does not enlarge their apparent diameters as it does that of nearer objects, and in the most perfect instruments they look the least. We see their

lustre, we note the colour of their light; Betelguese is a topaz, Rigel more of a sapphire, Antares is flushed, and flashes with blood red; and when the telescope has separated the so-called "double stars," we have contrasts of green, orange, blue, white, grey, etc., as Mr. Webb's admirable papers tell; but whether their surfaces are rugged and mountainous, smooth, with plains or seas, diversified in outline, or monotonous in uniformity, we can only guess; for, in spite of all our efforts, *we never see the stars.*

Ordinary objects reveal to us their forms by the effects of light, shade, and colour. They shine with borrowed, and often with feebly reflected light, so that by walking away, we soon lose sight of them altogether. Objects that are more luminous and brighter, show their forms at greater distances, and we often see things negatively that would be unnoticed by their positive effect. Thus a thin rod against a clear sky is seen a long way off, because we are conscious that the sky brightness is, as it were, cut through by some dark thread. But we may pass from all those cases in which light comes to us as a revealer of *form*, to others, in which it says, "I am light," and nothing more.

All "Intellectual Observers" know Longfellow's exquisite poem beginning—

> "The day is done, and the darkness
> Falls from the wings of light,
> As a feather is wafted downward
> From an eagle in its flight:"

and as they repeat the last two lines—

> "We see the lights of the village
> Gleam through the rain and the mist,"

they will recall an experience common to all travellers, the memory of which may bring with it either "a feeling of sadness which the soul cannot resist," or pleasing associations to which the affections cling. These "lights of the village" may help to teach us why "we never see the stars." They come to us like good angels across the moor, or fen, but their faces are hidden from our distant gaze. We do not see the lamp or candle from which they emanate until we are close to it, although we may know what it is, and exclaim with Portia:

> "How far that little candle throws its beams!
> So shines a good deed in a naughty world."

Unless we are tolerably near we do not even see the shape of the flame, and as soon as we have lost that shape, it is, on a small scale, an imitation of the distant stars.

The distance at which objects become invisible, although their light is still seen, varies with different eyes. Without light no man sees; but some men see with less light and much further than others, and long after the longest sighted man has lost all perception of bodily shape, the hawk tribe appear to see it

acutely, so that Tennyson was a true exponent of nature when he depicted the eagle in his home—

"He clasps the crag with hooked hands:
Close to the sun in lonely lands,
Ring'd with the azure world he stands.

"The wrinkled sea beneath him crawls;
He watches from his mountain walls,
And like a thunderbolt he falls."

When the sea waves are dwindled down to wrinkles by their distance, the king of birds still perceives upon their shore, objects that would be quite invisible to man; but there is no reason to believe that even the eye of the eagle has ever "seen the stars." The bird, however, may teach us that with perfect visual organs, remoteness would not prevent the discovery of form, but merely reduce its apparent size.

A distant body must have a certain magnitude, in order that its shape may be visible to any eye, with any particular instrument. The larger the body, the greater the distance at which its shape can be seen, under similar and proportionate illumination, but as the distance increases, the apparent size of any body is rapidly reduced, in conformity with a well-known physical law, so that the mightiest celestial orbs may dwindle through remoteness to the merest specks of light which the eye can discern, and by still further remoteness, completely elude the power of the largest telescope.*

We know that the sun's diameter is, according to the best calculations, 850,100 miles, and his distance, by recent determination, about 91,328,600 miles, nearly four hundred times that of the moon. Now the enormous face of the sun, more than one hundred times broader than that of our earth, is eclipsed by a pin's head held near the eye, and it only appears the size of a very small disc held a foot off. Could we pass from our present abode to the more distant planets of the solar system, the great luminary would become smaller and smaller in appearance; and from Neptune, "$30\frac{1}{5}$ times the mean distance of the earth from the sun,"† it would look like a mere point of light that would require considerable magnifying to raise into a disc. Mr. Breen tells us that with a power of 150 we can see the appearance of a disc in Neptune "if we consider it attentively," and the body which thus requires enlarging to the extent of 150 diameters, or 22,500 times superficially, in

* An easy mode of illustrating these facts, is to cut a disc, one inch in diameter, and a triangle (with each side equal to the diameter of the circle), of white paper; stick them against a wall, and walk backwards until the eye fails to see which is the circle and which is the triangle, although two patches of white light will still be discerned.

† Breen's *Planetary Worlds*, page 248.

order to be seen at all, is 108 times as big as our earth;* its diameter is 35,000 miles, that of the earth being 7912 miles.

Under ordinary circumstances we do not, without magnifying them, see the real discs of the great planets, otherwise we should need no telescope to teach us that Venus goes through phases like the moon.† When Venus is favourably situated she is a highly lustrous body, that *looks* the same shape as Jupiter, but if the telescope be directed to both, one shows a round face, and the other may appear as a thin crescent of most glorious light. Although the planets are too far off to exhibit real discs to the naked eye, still their being so near in proportion to their size is one reason why they shine with a steadier light, and do not twinkle like the stars. Humboldt and others thought that when light, from one portion of their discs, was for a moment intercepted and then permitted to pass through the air, they did not flicker like stars, because light from other portions of their discs filled up the vacancy that was occasioned, and kept their lustre steadily in view. This cannot be the entire reason of stellar scintillation, as some stars do it much more than others; but whatever action such discs may have, it must lessen, and finally vanish as their distance is increased; and we must not forget that Neptune, the remotest known member of our system, although 2,864,000,000 miles from the sun, is near him, and near us, when compared with the nearest of the stars.

Spectrum analysis bids fair to teach us what the stars are made of, and we may learn more and more of their wondrous ways. Still we may never behold their faces, nor our descendants after us, to the end of time. We place, however, no limits to the future possibilities of science, but the present generation of men, and their long posterity after them, may be compelled to wait for immortal vision before they will really *see the stars.*

* The dimensions and distance of Neptune, and other planets, will have to be revised, to meet the present views of the size and distance of the sun, but this will make no difference in the argument.

† This remark is generally true. Had it been otherwise it would not have been necessary to wait for Galileo with his telescope, in order to learn the fact that Venus exhibits phases like the moon. Mr. Webb, in his excellent work, *Celestial Objects for Common Telescopes*, says, speaking of Venus when near the earth and exhibiting a sharp and thin form:—"This crescent has been seen even with the naked eye in the sky of Chili, and with a dark glass in Persia." Difficult objects become more visible when the mind knows exactly what the eye ought to see, and the eye is practised in looking for it. An easy experiment will illustrate this. Let any one not accustomed to it, look for ε Lyræ, which to the naked eye lies close to Vega. The first night of the attempt the small star may not be distinguished, afterwards it will become plainer, and if it is looked at fifty or one hundred times in the course of a month or two, it will seem to have moved further off, and the observer will wonder why the separation did not strike him at first. A similar apparent increase of distance takes place by continued observation of close double stars through a telescope.

GREEN ICE.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

IT is sometimes worth while to remark upon a subject that may appear common-place, and I am induced to say a few words upon the often-noticed phenomenon of ice being coloured green by its enclosing confervoid vegetation, simply upon the ground that as it has lately interested me, it may interest other constant readers of the INTELLECTUAL OBSERVER. During the severe frost of January, I was walking, on a clear sunny day, in company with a friend, when our attention was drawn to the brilliant green tint of sundry masses of ice scattered over the frozen surface and about the margin of a pond, on the Lower Heath, Hampstead, near the queer looking edifice dedicated to the water gods of the place. A man was amusing himself with a pickaxe breaking up the ice near one end of the pond, and scattering the fragments about him. Some he sent whizzing along the frozen water, and its surface was soon variegated by masses that gleamed with a beautiful beryl tint. Taking up some of these pieces I was struck with the small quantity of green matter that sufficed to tinge a considerable block, and as the cold was intense, I put a fragment in the pocket of a large great coat, just wrapped in a piece of paper, and thus carried it home nearly dry. Placed in a white porcelain vessel in my study it soon thawed, and at the bottom of the water was a little green stuff, which microscopic examination showed to consist of a minute oscillatoria, and some other conferva of which I don't know the name. These little plants seemed quite alive, as a high power detected no sign of decay in their bluish green chlorophyll; but their life processes must have been comparatively quiescent, as they remained for some days at the bottom of the vessel. Had they been active I presume they would have evolved enough air-bubbles to have caused them to float. A few days afterwards I went for a fresh supply, and found every piece of ice I examined very irregular in structure, and full of cavities I took for air-bubbles. A pocket lens showed the parallel planes of freezing very prettily, but did not detect any cavities round the conferva, which was disposed in minute tufts—not at all close together. I did not in any case see any conferva in an air-bubble, or any distinct air bubble attached to a conferva. Some masses of ice of an intense beryl green were broken with a hammer, and it was curious to remark how very small a quantity of the vegetable matter, distributed as I have described, tinged the whole

mass. The colour rapidly diminished as the lumps were reduced in size, and fragments an inch or two square only showed the tint where the little patches of converva actually occurred. In some instances the vegetation was somewhat more plentiful, and then the ice had to be reduced to still smaller pieces before the green hue disappeared.

I brought home several fragments of the ice in a bottle, but as the weather was not so cold as on the former occasion, about one third melted as I came along, and probably the condition of the solid masses was changed. Small pieces were placed on a strip of glass on the stage of the microscope, and examined with a three-inch object-glass, the light being thrown up strongly by means of the concave mirror. Under these circumstances the ice appeared anything but homogeneous. There were lots of bubbles, and a great confusion of optical surfaces, bounding portions of different density, and portions to which the crystalline structure gave a difference of refractive power. The conferva seemed closely surrounded by unfrozen water, and here and there a little air-bubble appeared, touching the delicate green threads. Was the conferva left in a little water-drop when the gelation took place, or, when thawing began, did it take place first round the delicate plants?

In his *Heat Considered as a Mode of Motion*, p. 318, Professor Tyndal gives a very interesting account of little water chambers, with air-bubbles in them, which he found in Norway ice, and he proved that they had been occasioned by melting minute portions of the block. "If," said he, "the liquid is the product of melted ice, its volume must be less than that of the ice that produced it, and the associated air-bubble must consist of rarified air." To test this, he melted some of the ice in warm water, and found the air-bubbles shrink in volume at the moment the surrounding ice was melted. In another experiment he placed a portion of ice in a freezing mixture, and froze the water-blebs. The ice thus treated "was immediately placed in a dark room, where no radiant heat could possibly affect it, and examined every quarter of an hour. The dim frozen spots gradually broke up into little water parcels, and in two hours the water-blebs were perfectly restored in the centre of the slab of ice. . . . . Hence no doubt can remain as to the possibility of effecting liquefaction in the interior of a mass of ice by heat which has passed by conduction through the substance without melting it." Thus the existence of water-blebs in ice does not prove that they consist of water left unfrozen when gelation took place; and I am disposed to think that the conferva threads were, as they looked under a hand-magnifier of low power, closely surrounded by frozen water, but not frozen themselves, because their cell contents

may demand, in order to be frozen, a somewhat lower temperature than that in which the water solidifies. When the mass of ice became warmer, and its outside was actively thawing, I imagine the conducted heat was arrested by the conferva, and thus the water-blebs round it gradually formed. If this were the case, the minutes air-bubble which I saw in some instances attached to the conferva, should have collapsed as the ice surrounding it thawed. I had not the means of ascertaining this, but the escape of the larger air-bubbles was a pretty sight when a lump of the ice was placed in a tumbler of warm water, and the melting process watched under a lens.

I believe Ehrenberg ascribed the escape of animalcules from being frozen to death when the water in which they lived congealed, to the action of their vital heat; but it seems to me more probable that they escaped because their vital fluids differed sufficiently from water to freeze at a lower temperature. Professor Tyndal, in the work cited, observes that there "seems no such thing as perfect homogeneity in nature. Change commences at distinct centres, instead of being uniformly and continuously distributed. . . . . . The melting temperature of ice is set down at 32° F., but the absence of perfect homogeneity, whether from difference of crystalline texture, or some other cause, makes the melting temperature oscillate to a slight extent on both sides of the ordinary standard." It may be that slight variations from that uniformity of condition which is described by the term "homogeneous," causes some particles of water to freeze quicker than others; and if so, we may imagine how slight a divergence in the molecular condition or composition of a fluid, from the condition and composition of water, may enable the liquid contents of a plant or animal to retain their fluidity when the water in which they are immersed takes the solid form.

The question of why so little green stuff deposited in patches considerably distant from each other, gave so deep a tint to the ice of my experiments, may perhaps be answered by reference to its heterogeneous structure. There must not only have been refractions but also reflexions in all sorts of directions, from crystalline surfaces in various planes. Thus I conceive the effect of a very little green stuff was made to go a great way. The explanation may not be correct, but I can think of no better, and perhaps the remarks I have thrown together may suggest observations and experiments to others, who may witness appearances of the same or a similar kind.

CLUSTERS AND NEBULÆ.—DOUBLE STAR.—GREAT NEBULA IN ORION.—COMPARISON OF SUN AND STARS.—OCCULTATION.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

8. *The Great Cluster near Propus,* alias 35 M. *Prŏpus* is the name given by the ancients to a small star, preceding the foot of the Twin, Castor, as its meaning implies, whose present appearance is so far from warranting any special designation that one might suppose it had declined in brightness. It may be found thus:—A line from ζ *Tauri* to *Pollux* will be nearly bisected by a considerable 3 mag. star, ϵ *Geminorum.* Between ζ and ϵ will be seen three others, which form a line pointing *n p*. The uppermost and smallest, 5 mag., is *Propus,* alias 1 *Geminorum* in Flamsteed's nomenclature, being the first star of that constellation as to right ascension comprised in his catalogue. A little *n f* from this star the naked eye perceives a faint white cloud, a *nebula proper,* unnoticed however by the ancients, though they called the head of Orion "stella nebulosa," and discovered by Messier in 1764. The finder shows us a starry nebula, which in the telescope is expanded into what Smyth calls a gorgeous field of stars, from 9 to 16 mags., less rich in the centre, with a tendency to curved arrangement. It is thus described by Lassell, as viewed with his 24-inch speculum, in the Maltese sky, 1852:—"A marvellously striking object. No one can see it for the first time without an exclamation. Power 160; the field of view 19′ in diameter, and angular subtense" (or apparent extent), "53½′, is perfectly full of brilliant stars, unusually equal in magnitude and distribution over the whole area. Nothing but a sight of the object itself can convey an adequate idea of its exquisite beauty. The brilliancy and concentration of the stellar points and the blackness of the ground cannot otherwise be shown in their just contrast." The possessors of smaller apertures must of course not expect to witness such a spectacle; yet it is a noble object in any telescope. To do justice to its wide extent we must employ a very low power; but a higher one will best bring out its finest feature, a slightly curved arc or festoon of stars, depending, when inverted, and in the eastern sky, from a larger one at each end. The chord of this arc, which lies *n f* and *s p*, continued for three or four times its length in the latter direction, will point out a small faint nebula among the outliers of the great cluster, unnoticed in the Bedford Catalogue, but entered in that of Sir W. Herschel, where it is 17, VI.; and in that of Sir J. Herschel, who numbers it 375, and calls it "rich,

middle compressed almost to nebulosity, stars very small, irregular triangular figure." I found it visible with a comet-power of 29, and resolved into stars with 164, having then somewhat of the aspect that its brilliant neighbour has in the finder.* There is something very striking in the juxtaposition of these two objects; the one viewed, at an inconceivably greater remoteness, as it would seem, through the straggling components of the other, but both, perhaps, of similar constitution and arrangement. The earlier ideas of Herschel I. as to the construction of the heavens would have led us to suppose that if we could travel with the velocity of light to the nearer of these clusters, we might still find the second no larger or brighter than the first now appears to us, while our own sun behind us, and all his attendant system, had faded into one of those minute points, whose aggregation alone renders them perceptible to the unaided eye. But further discoveries have thrown doubt upon these speculations, which, however magnificent, were premature; and we are now obliged to admit that with regard to absolute and relative distances in the starry heavens our data are few,—our fully reliable ones fewer still.

The neighbourhood of these clusters is rich and beautiful, being a portion of the galaxy. *Propus* itself, a yellow star, is closely preceded by a pretty 9 or 10 mag. triplet, combined with still smaller points; some way further in the same direction is an interesting group, and *n* of this latter a fine open pair, about 7 and 7½ mag. *η Geminorum*, an orange star, the next visible to the naked eye *s f Propus*, will guide us to a very remarkable coloured star, less than 1° *n p*. It is 6 *Tauri*, marked 6 mag. in the S. D. U. K. maps, but very small for that class; its fiery red hue, like that of Antares upon a small scale, makes it an interesting object.

If we now pass up the galaxy a considerable distance from this region, we shall find, in an extended portion of it before we reach the bright star *Capella*, three clusters worthy of a search, which, however, must be the more careful as they are not in distinctly marked positions. We must first draw a line from *Aldebaran* through *β Tauri*, and then bend it a little northwards, in the direction of *Capella;* this will point out *θ*

* It should be noticed that these two objects, 35 M, and 17 H VI, though not their designations, have *changed places* in the larger maps of the S. D. U. K., which are, generally speaking, very free from error. While correcting the mistakes of others, I would beg permission to do the same by my own. I have subsequently ascertained that the aperture of the Greenwich object-glass, referred to in the No. for December, 1862, p. 374, is 11¾ instead of 12¾ inches; and in the description of the great Nebula in Andromeda, published in our number for December last, p. 349, where it is stated that no confirmation of the stellar symptoms showed by the Earl of Rosse's 3-feet speculum was known to have been obtained with the larger reflector, it should have been added, that in this instrument the nucleus has that granular appearance which indicates resolvability.

Aurigæ, a solitary 4 mag. star, in a conspicuous position, just across the galaxy. Rather more than half way from *β Tauri* to *θ Aurigæ*, and a little below the line joining them, we must sweep about for—

9. 37 M. (*Aurigæ*). A cluster which will appear as a nebula in the finder, and in a low power eye-piece will open out into a beautiful irregularly circular cloud of minute stars of various magnitudes, melting away on every side into the surrounding galaxy. Long gazing seems to bring out more perfectly the exceeding beauty of this glorious work of the Creator. It also bears higher powers well, with which it occupies the field. Smyth truly describes it as a magnificent object, the whole field being strewed with sparkling gold dust, and the group resolved into about 500 stars, from 10 to 14 mag., besides the outliers. He does not, however, mention a brighter star pointed out by Knott in a conspicuous position near the centre of the cluster. It is probably, as the latter says, an illustration of the fact, that what strikes one person does not strike another.

As much above as we have been looking below the line joining *β Tauri* and *ϑ Aurigæ*, and not far from our last object, a little sweeping will bring a luminous cloud into the field of the finder, which is—

10. 36* M. (*Aurigæ*). A large, bright, scattered cluster, 8° to 14 mags., containing a double star, 368 H, 12″, 308·7, 8 and 9, both white.

If we place this object at the bottom of the field of the finder, we shall (if it is of an ordinary extent) perceive another less prominent nebulosity *n p*. This is

11. 38 M. (*Aurigæ*). Described by Smyth as a rich cluster, of an oblique cruciform shape, with a pair of large stars in each arm, and a conspicuous single one in the centre. It is best seen with a low power, and melts away into the surrounding galaxy. The neighbourhood is magnificent. A little *s* is a small cluster, 39 H VII, *alias* 354 H., who calls it pretty rich, counting in it 50 or 60 stars, 9 to 12 mag.: such was the working of his 18-inch speculum on this comparatively feeble and remote aggregation.

Descending the galaxy for a considerable distance, and passing our acquaintance *Propus*, we shall find a much older acquaintance, 8 *Monocerotis*, No. 101 of our Double Star List (Int. Obs., 1863, April, p. 217). About 2° E. of this, the naked eye will readily detect a nebulosity, which the finder will turn into a starry cloud. It is—

12. 2 H VII (*Monocerotis*). A brilliant group, containing stars from 7 to 14 mag—the latter, Smyth tells us, running in

* Wrongly numbered 56 in the maps of the S. D. U. K.

rays. It is 392 H. who calls it a large, poor (that is in numbers), but brilliant cluster. A very large field is required to do it justice, which will include towards its *sf* edge 12 *Monocerotis*, 6 mag., a fine yellow star.

If we go lower still towards the horizon, till we reach a line joining *Procyon* and *Sirius*, about one-third of the distance from the latter we shall detect by sweeping, a nebulous patch in the finder—

13. 50 M. (*Monocerotis*). A low power will here show us what Smyth justly calls a superb and very rich object, composed of stars from 8 to 16 mag., with spots of splendour indicating yet further masses. H. gives it a diameter of 10′ to 12′, and says the stragglers extend over a circle of 30′, as large as the moon. The mode in which it loses itself every way in the surrounding galaxy is very beautiful, as well as suggestive with regard to the constitution of that wonderful zone. The whole neighbourhood is superb, and will be swept over with a delighted gaze, minute sparklings breaking out throughout the whole extent of the field, and indicating the starry nature of the nebulous ground which fills it. A very moderate aperture, even under four inches, will suffice to indicate this resolvability, which will increase with every increase of light, till in the field of the great reflectors of Herschel, Schröter, and Lassell, the multitude of faintly-glittering points would prove that the whole of this vast stratum encompassing us on every side, is composed of stars: and every one of these literally millions of minute stars is a witness of the omnipresence and omnipotence of its Creator.

We will now turn to

14. *Præsepe* in *Cancer* (44 M). This celebrated cluster, which was well-known to the ancients, has been already referred to under No. 5 of our Double Stars (INT. OBS., I. 277), and may probably not be a stranger to us; however, it could not with propriety be omitted from the present list. It offers a perfect example of the process of nebular resolution, being barely resolvable without the telescope,* showing its components in the finder, and being widely opened out with high powers, while the reverse of this operation enables us readily to comprehend how clusters, fully separated to the naked eye, would become gradually compressed, and at length nebulous, if progressively removed to greater depths in space. The whole of Præsepe is too extensive to be included in an ordinary field; it is sub-divided into several groups, among which,

* Arago says, "It is impossible for mere unaided vision in any instance to separate" the stars. Their existence may, however, be recognized with little difficulty, giving a sparkling character to the mass. I have found the cluster much brighter by oblique vision.

pairs, triplets, and more complicated arrangements will be found. Two beautiful little triangles will be sure to attract notice.

DOUBLE STAR.

We shall meet with a beautiful object well worthy of being added to our former list by looking first for a considerable 3 mag. star, γ *Geminorum*, which lies between *Pollux* and *Betelgeux*, but nearer to the latter. A little *s f* from this star we shall notice two of the 4 and 5 mag., very near together, ξ^1 and ξ^2, and *s* again from these, a little *p*, another: this is the star of which we are in quest.

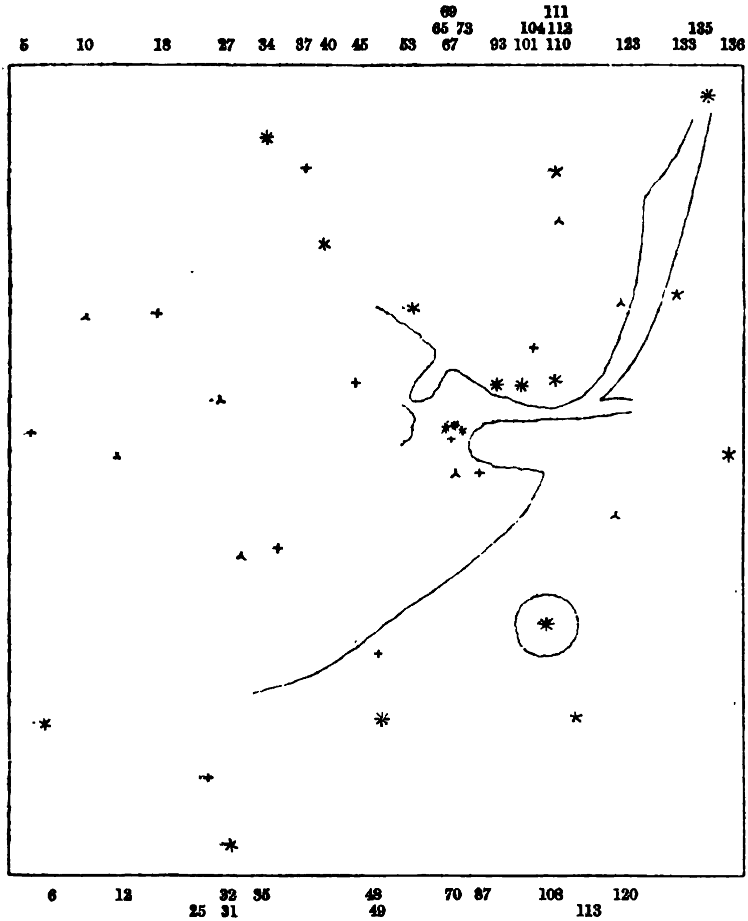
120. 15 *Monocerotis*. 2″·5. 206°·2. 6 and 9½, greenish and pale grey. This fine and easy object is converted into a triple group by the addition of a minute *comes*, which Smyth calls blue, at 15″ and 15°. He assigns to it only 15 mag., but I have found it more visible than I should have expected, being steadily seen with 5½ inches and a high power. Another still more minute attendant, unnoticed by Smyth, lies at a greater distance in the *n p* quadrant. Just *s* of the principal star, three other small pairs form an irregular transverse line across the field, and further in the same direction we shall find a fine group, requiring a low power. Many parts of this galaxy region are very glorious.

THE GREAT NEBULA IN ORION.

So lengthened a description of this nebula was given upon a former occasion, that some explanation seems requisite to account for its re-introduction at the present time. It is simply the result of a closer acquaintance with this great marvel of the heavens. A more careful telescopic examination of it than I had ever previously attempted, combined with a more extended comparison of the principal drawings of our great observers, has led me to think it an object worthy of much more, even at the hands of amateurs, than a passing gaze of wonder, and capable of repaying their diligent study and careful delineation. The discrepancies with regard more especially to the internal distribution of the luminous haze, as represented by our best observers, and by means of the finest instruments, are so obvious, that I feel less disposed than I should otherwise have done, to reject my own results, or think lightly of those of others, my fellow students, on the mere ground of their differing in some respects from all that has preceded them. Where the highest authorities differ, there is room for every man's independent work; and in such a case the aspiring sentiment of Tycho Brahe may be applied without diminution of the veneration with which we ought always to regard our masters in science :—

"Anne ita decet nos serviliter addictos aliorum prolatis, ut nihil in his ipsimet experiamur?"

A few favourable nights have shown me details which I know not how to reconcile with any designs which I have had an opportunity of examining, and there is reason to suppose that a similar examination in other hands would lead to analogous, though, very possibly, not identical conclusions. The feebler portions of the nebulosity are of course out of the reach of any but the most light-grasping instruments; but



[The figures placed above and beneath the diagram are the numbers by which the stars are designated, in the order of their Right Ascension, by Sir John Herschel, in his Observations at the Cape of Good Hope, and which have since been generally adopted. They are not introduced in the diagram for the sake of clearness, but they may easily be referred to their places by running a vertical line from each star to its corresponding number, above or below. The diagram is to be considered as bisected from right to left, just beneath the trapezium, the numbers at the top referring to the stars lying above the group, and *vice versa*.]

experience has led me to believe that a much smaller aperture than that of ten inches specified by O. Struve, as quoted in my former paper, is competent to deal with a fair proportion of its most remarkable features, and that many of our readers might find it highly interesting to make it matter of careful examination, and to record what they see for future comparison. To prepare for this by a wholly independent process of mapping out the included and attendant stars, would be not only very laborious, but a great waste of time, when a simple diagram will supply everything of the kind. Such a design is here given, inverted of course to suit the astronomical eye-piece; and a copy of it, especially if upon an enlarged scale, will serve at once as the groundwork of a delineation of the nebula.

The stars are by no means all that are visible with a 5½-inch object-glass, but they are such as seemed at once the most obvious and the most favourably situated; some pains have been taken with their relative magnitudes, but accuracy will not be expected; and the lines indicating the position of the nebulosity are inserted merely for more convenient identification, and should be omitted in preparing the copy for use. It may require a little perseverance, and the employment of various magnifiers (even high ones not being excluded), to make out the boundaries and details of the hazy mass, but habit will soon render its aspect familiar, and more intelligible than might have been at first expected. Attention may be particularly directed to the arrangement of the "flocculi," or cloudy wisps, in the bright region lying S. of the trapezium, as here they are most distinct, and appear to me to exhibit the least agreement with the published designs of our great observers; and should the attempt at delineation at first seem difficult or uninteresting, we may call to mind that within a short time, on this spot rather than anywhere else in the heavens, is one of the most remarkable of all astronomical enigmas likely to receive its solution—what is the true character of many of the nebulæ? Are they merely remote collections of stars? or are they luminous mists, of a nature wholly unknown, and subject to internal movements whose causes are now, and probably will ever remain, as Seneca says, "hidden in the majesty of nature"?

COMPARISON OF SUN AND STARS.

The celebrated American optician, Alvan Clark—whose gigantic 18½-inch object-glass, after receiving the Lalande prize of the Académie des Sciences, has recently been purchased by the Astronomical Association of Chicago for 11,187 dollars—has published an interesting account of his photometric experiments on the comparative brightness of the sun and the fixed stars.* Starting with the acknowledged optical fact, that

* *The Sun and Stars Photometrically Compared.* By Alvan Clark. 1868.

the focal image produced by a convex lens corresponds in apparent magnitude and brightness with the original object when viewed from a distance equal to the focal length of the lens, and diminishes in proportion as the distance of the eye increases, he proceeds to apply it experimentally in the following manner:—Having an underground dark chamber, 230 feet in length, communicating at one extremity with the open air by a vertical opening, he first reflects the sun's rays down this opening by an ordinary mirror, and then gives them a horizontal direction by means of a reflecting prism, on the inner face of which is cemented a little convex lens of $\frac{1}{20}$ of an inch focus. When the solar light is transmitted through this apparatus, an observer at the other end of the long gallery sees it reduced 55,200 times, in which condition its appearance differs but little from that of Sirius. The intention, however, being to obtain not a comparative but an absolute reduction to the *minimum visibile*, or the equivalent of a faint 6 mag. star, another lens of 6 inches focus is interposed between the eye and the minute lens, and made by means of cords to traverse the long chamber at the observer's pleasure, till the solar image, thus doubly diminished, is on the point of disappearance. The reduction obtained in this way, amounting to 1,203,360 times, indicates that the sun, at that distance, would be only just visible to the unassisted eye; while at 100,000 times his present distance, he would merely rank as a pretty bright first-magnitude star, though his parallax would be double that assigned to any star in the whole heavens. And hence he draws the following conclusion:—"If the distances imputed to several of the stars from parallax can be true, I am sure those having the taste, talent, and leisure necessary for following up photometrical researches with efficiency, cannot fail to find our glorious luminary a very small star; and to the human understanding, thus enlightened, more than ever must the heavens declare the glory of God." In confirmation of this result he subsequently removed the 8-inch object-glass from the tube of his equatoreal, and turned the eye-end to the sun, carrying two lenses of $\frac{1}{20}$th and $\frac{1}{34}$ th of an inch focus, at an adjustable distance from each other, and thus found, when his face was inserted in place of the object-glass, a reduction of about 1,308,000 times necessary to obtain the *minimum visibile;* a result sufficiently accordant with the former, when the very delicate nature of the investigation is considered. In the interesting paper, of which this is an abstract, the ingenious author has taken into account the loss of light in reflexion, and its increase from the strongly illuminated neighbourhood of the sun; and seems to have used every precaution in the conduct of his experiments. He adds that a similar mode of reduction brings the star Castor to the same point at a distance repre-

sented by 10·3; Pollux 11; Procyon 12; Sirius 20; the full moon 3000; whence it appears incidentally that it would take the light of 400 moons to equal that of the sun—a result very different from those hitherto obtained, which are however altogether discordant among themselves. Bouguer, for instance, gave the proportion 300,000; Robert Smith 90,000; Lambert 277,000; Wollaston 801,072. In speaking of a somewhat similar case, Sir John Herschel has observed that "discordances of this kind will startle no one conversant with photometry." But they evidently imply the necessity of further research: and whatever may be the comparative value of Mr. Clark's experiments (which could hardly have been undertaken by a more competent observer), they must be acknowledged to be an important move in the right direction.

OCCULTATION.

A single occultation only will be conveniently visible during the month of February. 20th, 60 Cancri, 6 mag., will disappear from 6h. 32m. to 7h. 34m.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ENTOMOLOGICAL SOCIETY.—*Jan. 4.*

INTRODUCTION OF WHITE ANTS INTO ST. HELENA.—A communication was read from the Lords of the Admiralty requesting the advice of the society as to the best means of securing the destruction of the white ants which had been introduced into James Town twenty years since, from the Coast of Guinea. Since which time they have multiplied to so great an extent as to have seriously injured every building in the town, and to have reduced some to such a state of ruin as to compel the inhabitants entirely to abandon them. General Sir John Hearsey related his experience respecting the white ants in India, and stated that if they once gained access to a house their eradication was generally regarded as impossible, unless the house was taken down and rebuilt. He suggested the steeping of the timber in a solution of quick lime; but as this would rapidly become converted into carbonate of lime by exposure to the air, it does not offer much promise of success. For small articles General Hearsey recommended a solution of corrosive sublimate. Mr. H. W. Bates, who has had much experience respecting these insects in the forests of South America, stated that they did not attack houses, furniture, or store boxes, constructed of a very hard wood called Acapù, and that it was customary to protect boxes, etc., of softer wood by raising them on blocks of acapù. When

the ants had gained possession he found that they might be expelled by the free use of the arsenical soap employed in preserving animal skins. This soap, which is a compound of common soap, carbonate of potash, and white arsenic, is made into a lather with water, and brushed over the articles which it is wished to preserve. The great objection to such a proceeding is obviously the danger to the health of the inhabitants from the dissemination of the arsenic into the atmosphere.

Mr. Robinson stated that the ravages of the white ants on the sleepers and other wood work of the East Indian railways had been entirely prevented by the use of creosote, but the exceedingly objectionable odour of this remedy would prevent its being used in a dwelling-house.

PHARMACEUTICAL SOCIETY.—*Jan.* 6.

PREPARATION OF ESSENTIAL OILS.—Mr. T. B. Groves suggested an exceedingly ingenious method for the separation of essential oils from watery solutions in which they exist in small quantities, such solutions being frequently produced by the distillation of aromatic herbs, etc.

A proportion of olive oil is added to the aromatic solution; this is then formed into a soapy emulsion by the addition of potash. When this emulsion is destroyed by the addition of an acid, the olive oil rises to the surface, bringing with it all the aromatic oil, which may then be readily dissolved out of the fatty oil by agitation with rectified spirit.

LONDON INSTITUTION.—*Jan.* 20.

SOURCES OF THE NILE.—Dr. Beke delivered a lecture on the Sources of the Nile, in which he demurred altogether to the conclusions of Captains Grant and Speke, as to the origin of that river in the Lake Victoria Nyanza. Dr. Beke maintains that the Nile merely flows through the Nyanza Lake, its true origin being in the Mountains of the Moon, which run from north to south parallel to the east coast.

The mountains laid down by Captain Speke at the northern extremity of the Lake Tanganyika, are stated by Dr. Beke to be entirely imaginary.

Dr. Beke stated that Captains Grant and Speke had left a most important part of the river unexplored, namely, a large bend that extended for at least 200 miles, and that in this portion there was a fall of 1000 feet, which had not yet been examined or explained. The true source of the Nile Dr. Beke maintained to be the range of snow mountains on the eastern side of the Nyanza Lake, a district unexplored by Captains Grant and Speke's expedition. The maps exhibited by Dr. Beke showed that the recent explorations proved the correctness of the theories he had submitted to the Geographical Society in 1849, and he proposed to undertake again in person the command of another expedition, which would be

confined entirely to the south side of the equator, as the northern part of the river is being investigated by Madame Tinne's party, which includes several scientific observers, as the Baron Von Heuglin.

LONDON MICROSCOPICAL SOCIETY.

HELD AT KING'S COLLEGE, *Jan.* 13.

Charles Brooke, Esq., President, in the Chair.

Dr. Lionel S. Beale read a very interesting paper on the white blood corpuscles, after which a very animated discussion took place, in which the President, Dr. Carpenter, Mr. A. Brady, Mr. Samuelson, Dr. Beale, and Mr. H. Lobb, took part. The discussion was chiefly between Dr. Beale and Dr. Carpenter, and elicited considerable applause from the meeting.

A new table for heating slides while mounting was exhibited by Mr. D. Everett Goddard, and which is certainly a great improvement on those previously in use. Instead of heating the slide by placing it on a flat metal, the table is so constructed that the centre of the slide is heated by radiation, and the balsam in which the preparation is mounted does not come in direct contact with the hot metal plate.

NOTES AND MEMORANDA.

RECENTLY NAMED LUNAR CRATERS.—Mr. Birt, of Hartwell Observatory, has communicated to the *Astronomische Nachrichten* the following notes on craters he has recently named.—405, 406. The Coxwell Mountains skirt the S.W. edge of Palus Somnii, Mount Glaisher being the culminating point just south of Proclus. 407. Chevallier. A full-sized crater near Atlas. It is rather shallow, and has some formations within. 408, 409. Moigno and Peters are two somewhat similar and rather conspicuous craters when the Terminator is near them. They are in the neighbourhood of Christian Mayer. 410. The Teneriffe Mountains are the detached rocks on the Mare Imbrium, south of Plato. They are respectively designated Petora, Guajara, Pico, Rambleta, Alta Vista, and Chajorra. The remarkable range between Plato and La Place is provisionally called "Straight Chain." A chart of the Teneriffe Mountains is in project. 411. Piazzi Smyth. A small crater near Kirch, it is between Petora and Guajara. 412 to 415. Herschel II., Robinson, South, and Babbage form a fine group hitherto unrepresented as they appear in our lunar maps. An account of this group will be found in the "Report of the British Association for the Advancement of Science, for 1862," page 9; Transactions of the Sections. 416. The Percy Mountains, extending from Gassendi to Cavendish, form a fine chain with crater openings. This chain is interrupted by Mersenius. 417. Rosse. A fine walled plain, hitherto unrepresented. 418 to 421. J. Franklin, Crozier, and MacClure form a bold headland, projecting with the Mare Fecunditatis opposite the Pyrenees. 422. Wrottesley. A crater eastward of and adjoining Petavius. 423. Phillips. A large crater adjoining Wilhelm Humboldt. It is lettered "Humboldt," in Beer and Mädler's, and also in Le Couturier's maps; but the large crater rather west is really W. Humboldt. Beer and Mädler describe it as such. 424. The Mare Smythii, named Kästner by Schröter, but very imperfectly represented by Beer and Mädler, as to require some change. The numbering is carried on from the Rev. J. W. Webb's catalogue in his very useful work, *Celestial Objects for*

Common Telescopes. Those localities marked (412, 3, 4, 7, 24) are unrepresented in Beer and Mädler's large map, but some very imperfect indications of them exist. The authority for the Selenographical Co-ordinates is Beer and Mädler's map. They however require a careful redetermination. It is proper to add to this list "Le Verrier," the name given in Le Couturier's map to Beer and Mädler's Helicon A. in N. lat. 40° 11′ and E. long. 20° 25′.

Snow Fall and Wind Storms.—Marshal Vaillant says that the storm from which the fleet suffered in the Black Sea, in November, 1854, was caused by a heavy snow fall on the Caucasian Mountains. He imagines that the storm of 2nd and 3rd December, 1863, may have arisen from a great snow storm in Scotland, producing intense cold, that acted on the warm south wind that was prevalent in Europe. Such snow storms might doubtless exert such an effect, but is there any evidence that a sufficient snow fall did occur in Scotland at the time?

Human Fossils from Bruniquel.—M.M. Garigon, Martin, and Trutat describe in *Comptes Rendus*, two fragments of human jaws discovered in the cavern of Bruniquel (Tarne et Garonne). This cavern is in a Jurassic limestone, and the soil found in it is formed by the superposition of several layers, which the writers examined at a depth of three metres. First was a stalagmite deposit of 22 centimetres; then an osseous breccia 1m. 48; then black clay beds repeated several times, in the midst of which was a *pell mell* of wrought flints of all known shapes; barbed arrow points; bones of carnivores, ruminants, and birds, and rounded pebbles. The writers remark that "the reindeer is characteristic of the age of this cavern, and that bearing in mind the four divisions established by M. Lartet for the quaternary epoch, we see at once that it is to the third palæontological epoch that we must refer the filling up of this excavation." The two human jaw fragments were found in the presence of several witnesses, at a depth of about two metres, in a bed of clay, containing quantities of charcoal, wrought flints, and bones of ruminants. After various anatomical details, the writers observe—"Three human jaws are thus referred to the same type—brachycephalic —although they belong to epochs completely separated one from the other; that of Aurignac, with which was found the *Ursus spelæus;* that of Moulin Quignon bedded with *Elephas primigenius*; and that of Bruniquel lying in the midst of bones of the reindeer." Amongst the bone fragments of this cave was found the humerus of a big bird, on which was roughly sculptured different parts of a fish.

Are Different Bodies Luminous at the Same Temperature?—M. F. de la Provostaye details in *Comptes Rendus* a process of theoretical reasoning, by which he arrives at the conclusion that different bodies progressively heated, do not become luminous at the same temperature.

Beale on Blood Corpuscles.—In a paper which will be found in the *Quarterly Journal of Microscopic Science*, Mr. Lionel Beale says—"It is most remarkable that the red colouring matter of the blood corpuscles of different animals should crystallize in different forms; and there are instances of animals closely allied to each other, the blood crystals of which are quite distinct; for example—the red colouring of the guinea pig assumes the form of tetra-hedra, while that of the squirrel crystallizes in six-sided plates, and that of the hamster in rhomboidal crystals." With reference to the condition of different portions of the blood, Professor Beale observes—"In man and in mammalia there are circular coloured corpuscles without a nucleus, and the so-called white or colourless corpuscles, which are spherical. Now I believe that the 'colourless corpuscles,' and the 'colourless nuclei' of the red corpuscles, consist of matter in a living state, while there are reasons for the conclusion that the coloured material has ceased to exhibit vital properties." While admitting that under certain circumstances the appearance of a cell-wall is produced, Professor Beale alleges various reasons for denying that such a structure is essential to a blood corpuscle. In concluding his paper he expresses his belief that "the red material is not living, but results from changes occurring in colourless living matter, just as cuticle, or tendon, or cartilage, or the formed material of the liver cell, results from changes occurring in the germinal matter of each of these cells. The colourless corpuscles, and

those small corpuscles which are gradually undergoing conversion into red corpuscles, are living, but the old red blood corpuscles consist of inanimate matter."

LEAD RINGS FOR MICROSCOPE SLIDES.—Mr. John Butterworth, of Moorside, near Oldham, writes to us that he cuts rings from lead tubes with a tenon saw, and finds them answer very well. Any inequality left by the saw can be removed by a file. Similar rings could easily be punched out of sheet lead of various thicknesses, but they would not be adapted for fluids, most of which would corrode them.

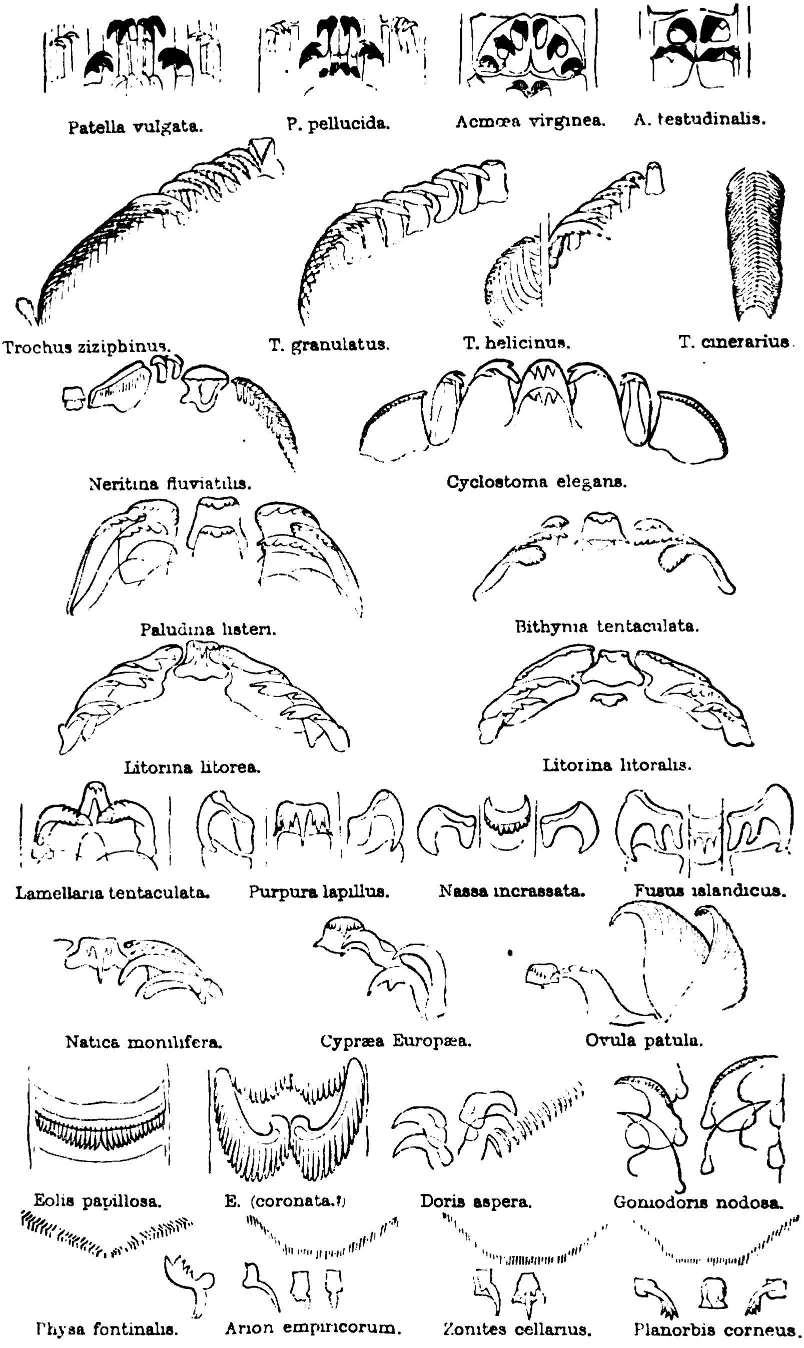
MR. GLAISHER'S 12TH JANUARY ASCENT.—This ascent took place from the Arsenal, Woolwich, at two p.m., and the descent shortly after four at Lakenheath Warren, near Brandon. On the ground at starting the temperature was 42°, but at the height of half a mile it was nearly 4° warmer. At this height, Mr. Glashier had usually found it from 12° to 16° colder. The warm stratum of S.W. wind was fully 3000 feet thick. The greatest height reached was 13,000 feet, when the darkness and fear of drifting seaward rendered a descent prudent. At starting, dew was deposited at 35°; at 36°, between 1500 and 3000 feet elevation; and at zero, near 9500 was reached.

STRANGE WEATHER FACT AT MILAN.—We learn from the *Presse Scientifique* that on a date not given, although the sky was quite clear, the earth was covered with moisture, and the houses dripped as if drenched with rain. The supposed explanation is that the houses and soil had previously grown cold, and that a warm current of moist air was impelled against them. It is curious that no mist is reported as seen near the ground.

LOSS OF MEMORY.—"The celebrated Professor Lourdat, of Montpellier, was obliged to recommence his medical studies from the very beginning after terminating them with distinction, a typhoid fever having destroyed the fruits of five or six laborious years."—*Presse Scientifique.*

SPONGE SPICULES.—Dr. Wallich, in a paper on Mineral Deposit in Rhizopods and Sponges in *Annals of Natural History*, gives a new view of this subject, according to which, when a spicule is to be formed, a vacuole of similar shape makes its appearance in the sarcode, and its long axis is traversed by a thread of sarcode, which he calls a *vacuolar stolon*. The stolon and the walls of the vacuole each secrete a layer of silex, after which the stolon usually diminishes in size, and secretes fresh layers of silex to occupy the vacancy. Layers of silex may, however, in some cases be deposited externally, and to make room for them the walls of the vacuole must recede. The mode of growth he considers different from what takes place in the mineral deposits of rhizopods.

THE LIVERPOOL EXPLOSION.—On the 15th January, at 7.25 p.m., the "Lotty Sleigh," containing about eleven and a half tons of gunpowder in 940 quarter kegs, blew up between Monk's Ferry and the Tranmere Slip, in the Mersey. The *Liverpool Post* described two distinct explosions; but three separate shocks were felt at Ross, where also the sound was heard. Tremendous air waves were produced at Liverpool and Birkenhead, bursting open strong doors that were locked and barred, smashing an immense quantity of glass, and putting out the gas lights. At Gloucester the shock was felt, and likewise at Blockley, in Worcestershire. The report was so loud at Chester, that the authorities telegraphed to Liverpool to know what was the matter. For many considerations belonging to such concussions we must refer our readers to the article on "The Philosophy of Earthquakes," in our number for December, 1863. We may add that Mr. Mallet found that the wave of the Neapolitan earthquake, which he investigated, travelled at the rate of 658·2 feet per second. How does this coincide with British experience in the Liverpool explosion shock? Perhaps the Ross observer felt the two shocks directly arising from the two explosions, and a reflected shock resulting from one or both.



PALATES OF MOLLUSCA.

[illegible]

[illegible] the pr[illegible]
[illegible] mollusk
[illegible]

[illegible]

THE INTELLECTUAL OBSERVER.

MARCH, 1864.

THE DENTITION OF BRITISH MOLLUSCA.

BY THE REV. G. ROWE, M.A.

(*With a Tinted Plate.*)

By way of preface, it will be well to remind the reader that the class *Mollusca* admits of a general subdivision into *Acephalous* and *Encephalous* animals, the latter alone possessing heads. And although it by no means follows that they should therefore possess teeth, or that their headless relations should not have these useful instruments, yet it is among the *Encephala*, or *Gasteropods*, that we find the subjects of our present observations. These creatures are also, for the most part, occupants of a single shell, such as that of the whelk and the limpet, but some, as the land-snails and the beautiful nudibranchs of the ocean, are naked.

The *teeth* of a Gasteropod do not answer to the ordinary signification of the term. They are organs of trituration and abrasion indeed, but are not used for the purposes of holding or biting. Many of the shell-less mollusks have one or more horny mandibles; and in some instances these are replaced, and even supplemented, by buccal plates armed with spines. Such is the case with the genus *Natica,* and with *Cypræa Europæa.* And Woodward states, that many of the flesh-eaters have a spiny collar at the end of their flexible proboscis. These afford the means of holding the food or prey, while, what I have here termed teeth, are employed in rasping it into the mouth. The so-called teeth are silicious plates of extreme tenuity, often beautifully outlined and curved, and frequently serrated at their edges. There are generally a great number of them, sometimes many thousands, in one animal; and they are rooted in a thin membrane, named, from its form and position, the *dental* or *lingual ribbon.* As this lingual band forms a very interesting object for the microscope, and only requires a little

practice for its preparation, I will briefly describe the process, in the hope that some of my younger readers may be induced by its easiness to attempt it.

There need be no lack of subjects for examination. Periwinkles, whelks, and limpets are to be obtained in most places, even inland; but if these sea "fish" are not to be had, then every ditch will yield *Limnæi* and *Planorbes* in abundance, or, as a last resource, the common snails and slugs of the garden and the lane must serve the turn. The apparatus may be the simplest possible. One or two ordinary needles and as many surgical ones may be fixed into cedar pencil-sticks, or, better still, into the neat little bone holders used by ladies for their crochet-hooks. A few sharp pins will be required to hold down the parts. A common pocket-lens must be mounted so as to slide on an upright rod (a piece of soft wood stuck into a flat bit of lead will answer every purpose), for the dissection necessitates some magnifying power and both hands must be free. It will also be well to have a pair of small curved-pointed scissors, and a pair of forceps with claw-ends. They will be wanted for the larger mollusks; but in many instances the needles only can be used, on account of the great delicacy of the operation. The prime requisites are patience and light fingers; and assuming that the observer possesses both, let us now proceed to work. Select for a first example a good-sized periwinkle. If he is alive, scald him for a second, and then you will not be haunted by any qualms about vivisection; but it will not matter for the nonce if your subject has been boiled and even salted. Break the shell with a smart blow, and disengaging the animal, pin him down with his *foot* or walking-surface underneath. Above, and in front, there will then be seen a loosish flap of skin: that is the *mantle*, and on turning it back, it will disclose the *rostrum* or muzzle. It has two little fleshy *tentacles* at the sides (corresponding to the horns of a snail), and a small nearly circular aperture at the extremity, which should be turned to the right. Now, cautiously insert the curved point of the scissors and lay open the cavity of the mouth, but take especial care not to injure its floor, where it is paved with the tongue and its wondrous armature of teeth. If they are in the way, pin back the cut edges, and, with the needles, lift out the lingual band. It comes away readily, and as all the teeth are reflexed it may be drawn out forwards without risk of injuring them. It will probably require cleaning, which is most conveniently managed under transmitted light. In some of the minuter examples, indeed, the whole process must be so done. To effect this, get a cigar-box; turn it on one side and make a clean hole in the upper one, half an inch in diameter. A small mirror, or piece of plain

glass blackened at the back, is to be placed inside at such an angle as to reflect the light through the hole. The object is then laid on a glass slide over the opening and cleaned with a camel-hair brush and distilled water.

Only a portion of the tongue is in use at any one time. This is nearly flat and is held in its place by projections of the membrane on either side. The posterior part descends obliquely behind the mouth, and is formed into a cylinder by being enclosed in a membranous tube, which peels off like the finger of a glove turned inside out, and allows the whole of the lingual ribbon to be displayed as a flat strap. If particles of tissue adhere to it, they may be carefully removed by the brush, or the curved needle. But being very delicate, the tongue is often liable to be torn, if held meanwhile by a hard point; for this purpose a bristle is a very handy tool. The front of the tongue is in some cases folded at its end, so that the part most in use is at a short distance from the extremity. This happens especially with the carnivorous species which bore through the shells of their prey. The teeth on this portion are frequently worn down and broken, and as it is essential to the well-being of the animal to have good teeth, the reserve so bountifnlly provided is brought gradually forward, the worn part being at the same time absorbed. Thus a continually new rasping surface is secured. Quite at the hinder end of the tongue the teeth become rapidly imperfect and rudimental; but it admits of doubt whether they are in the act of growing, since the lingual band would appear to be originally prepared of such a length as to last effective as long as its owner requires it. In our periwinkle, the spare portion will be found beautifully coiled up in the body of the animal on the right side. That of the common limpet passes backwards and downwards, doubling on itself in its course, and is more than twice as long as the mollusk.

The tongue itself is divided for convenience of description into longitudinal areas, which are crossed by the rows of teeth. Of the former there are five, distinguishable by the different characters of the teeth they bear; but they are not always all present. The teeth are consequently named the *median*, the *lateral*, and the *uncini*, although the latter are not necessarily more hooked than the others. The areas bearing the *uncini* have been called *pleuræ*. Since each row is a repetition of all the rest, the system of teeth admits of easy representation by a numerical formula, in which, when the *uncini* are very numerous, they are indicated by the sign ∞ (infinity), and the others by the proper figure. Thus, ∞. 5. 1. 5. ∞, which represents the system in the genus *Trochus*, signifies that each row consists of one median, flanked on both sides by five lateral teeth, and these again by a large number of *uncini*. When only

three areas are found, the outer ones are to be considered as the *pleuræ,* inasmuch as there is not unfrequently a manifest division in the membrane between them and the lateral areas; but never, as far as I have observed, between the latter and the median region. This arrangement is typical of a large class, having the formula 3.1.3, which embraces genera so dissimilar as *Cypræa, Aporrhais,* and *Natica,* together with the vegetable feeding *Littorinidæ,* and the operculated land and fresh water mollusks. Again, when only two areas exist, it seems probable that this is caused by the absence of the central ones, and the teeth should therefore be termed *uncini.* Such is the case with the *Bullidæ* and the allied bare-gilled family of the *Doridæ;* and this conjecture is confirmed by the fact, that in *Cylichna* and its nearest allies, which are transition genera, a minute central tooth is present.

This subject has been investigated by several naturalists; abroad, by Lovén and Troschel, and at home by Gray and Woodward, with a view to obtaining criteria for a systematic arrangement of *Gasteropodous Mollusca.* Up to the present time, however, their labours have only partially succeeded. The union under one formula of so many creatures widely differing in shell, anatomy, and habits, clearly indicates, that if the lingual ribbon contains generic characters, they have not yet been ascertained. At the same time, it does present differences which may offer collateral evidence in cases difficult of discrimination. It does not help us to separate carnivorous from phytophagous animals; but it seems possible to make use of it as a mark between species. For, in all the examples I have examined, there is a distinct difference between the tongues even of the most closely allied. *Chiton discrepans* is hard to tell from *C. fascicularis* by the outer parts alone; but the tongues are clearly distinct. *Patella athletica* may, it is said, be similarly divided from *P. vulgata.* The two British species of *Acmæa* afford remarkable differences. *Trochus ziziphinus* and the nearly allied *T. granulatus* is another case in point. On the other hand, the occurrence in *T. helicinus* of six laterals is one of the reasons which suggest a change in its generic name; and great lingual dissimilarity demands the separation of our two fresh-water *Ancyli.* In this way supposed varieties may be possibly decided. If, for instance, the lingual ribbon of the many subdivisions of *Litorina rudis* is constant in its characters, they cannot be received as species. Again, the position of the fluviatile *Paludinidæ* in close proximity to the sea-loving *Litorinidæ* is confirmed by the likeness of their dentition; while *Neritina fluviatilis,* with the formula ∞. 3. 1. 3. ∞, shows an approach to the genus *Trochus.*

All the land and fresh-water mollusks without opercula

show a great similarity in their dentition. Their tongues are "like a tesselated pavement," so regular are their numerous teeth. These are mostly rectangular in ground-plan, and armed with a single (or sometimes triple) recurved point. They are often so very minute, that their characters are barely discernible, even by the aid of the best lenses. When this happens, we may avail ourselves of the rule established by Mr. W. Thomson, who first in England directed attention to this subject. He found that the form of the whole transverse row corresponds to certain peculiarities in the teeth, to such an extent as to be an almost equally safe guide in questions of affinity. Thus, each row passes straight across the tongue in *Planorbis albus* and *vortex*, is curved in *Limax marginatus*, and suddenly bent in *Zonites cellarius*. Whence it may be inferred that the teeth are all similar in cases like the first named, and gradually or suddenly differ in the others respectively.

It is among the in-operculated members of the order *Pulmonifera* that we meet with the most astonishing instances of large numbers of teeth. *Limax maximus* possesses 27,000, distributed through 180 rows of 160 each. *Helix pomatia* has 21,000; and its comparatively dwarfed congener, *H. obvoluta*, no less than 15,000. When it is remembered that these estimates refer to series of forms, often elegantly curved and sculptured, the total area sustaining them not measuring at the utmost more than half an inch long and one-eighth broad, we must be filled with admiration at the marvellous prodigality of the great creative power thus bestowed upon such a small part of the organization of an humble snail. And when I ask my readers to examine these things for themselves under the microscope, I venture to think that the varied and beautiful outlines and serried ranks of these delicate amber-coloured atomies will be viewed with a delight whose depth and intensity the observers of nature can alone rightly measure.

The examples figured in the plate are drawn from original preparations,* and represent the principal types. And in the following table I have placed the genera known to me under their respective formulæ, as some guide to the student of these objects. The group characterized by the numbers 1. 1. 1 will be noticed as the best, the animals being all flesh-eaters, with the exception of, perhaps, *Lamellaria*. The generic names are those employed by Forbes and Hanley, in their *British Mollusca*.

* Those of Lamellaria, Doris, Goniodoris, and Eolis papillosa are from preparations kindly lent me by Mr. Brady, York.

1		1		1	Dentalium, Lamellaria, Murex, Purpura, Nassa, Buccinum, Fusus.
3		1		3	Calyptræidæ, Paludinidæ, Litorinidæ, Aporrhais, Natica, Velutina, Trichotropis, Cyprea, Ovula, Cyclostoma.
3		0		3	Acmæa.
1		0		1	Mangelia, Philine (Cylichna?), Bulla, Goniodoris.
∞		0		∞	Scalaria, Doris.
0		1		0	Eolis.
∞		1		∞	Many of the section In-operculata.
5	1	1	1	5	Chiton.
3	3	0	3	3	Patella.
∞	5	1	5	∞	Fissurella, Haliotis, Trochus.
∞	6	1	6	∞	Trochus (Margarita) helicinus.
∞	4	1	4	∞	Emarginula.
∞	3	1	3	∞	Neritina.

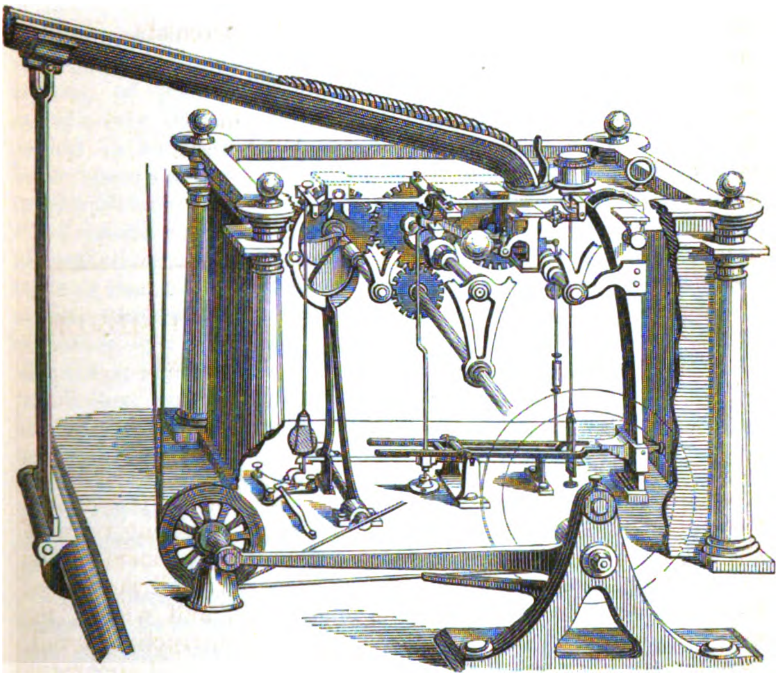
AUTOMATIC WEIGHING OF GOLD AND SILVER PLANCHETS AT THE ROYAL MINT.

BY JOSEPH NEWTON..

(*With an Illustration.*)

The marvellous progress which has been made in mechanical science in this country during the last half century is nowhere more practically demonstrated than in the new weighing-room of the Royal Mint. That handsomely-appointed apartment of the money-making establishment contains twelve small machines, each one the counterpart of its neighbour, and which, for delicacy of finish and beauty of minute constructive detail, may be said to equal, if not to excel, any mechanical apparatus owing its existence to the conception and the fingers of man. They appear, indeed, when in motion to be gifted with intelligence, and they certainly constitute the nearest approach to thinking machines that have as yet been contrived.

The task of the automatic weighing-machines of the Mint, is, to receive each individual planchet or disc of the precious metal produced by the laminating mills and cutting-out presses, and to answer the question as to whether or not those planchets are of the legal weight, which qualifies them for conversion into current coins of the realm. This highly important duty the automatons perform with a degree of speed, regularity, and accuracy impossible of achievement by direct human agency. No matter what the extent of skill, care, and aptitude the mani-



THE AUTOMATIC WEIGHING BALANCE AS USED AT THE ROYAL MINT.

pulator might bring to the work, he could not—as has been over and over again proved—weigh planchets of gold or silver to the extreme nicety which the Mint machines have been made to reach. Through their media the infallible and beautiful law of gravitation is enlisted into the service of her Majesty's coiners, and the results obtained thereby are as unfailingly constant and exact as is the action of that law.

Before proceeding to describe more closely the principle and the peculiarities of construction of the automatic balances, it may not be improper to offer a few remarks upon the great importance to the Mint and to the community at large, of the accurate weighing, or "sizing," as the ancient term stands, of pieces of gold or silver intended for transformation into the circulating medium. From the very earliest period in the annals of minting, its consequence and value have been recognized. Even before coins were in use at all in the British islands, and when slips or cuttings of the precious metals represented money, the sizing of those slips was necessarily attended to, and that with as much care and exactitude as the rude appliances of the time admitted. It was usual at that remote era—which was immediately preceded by the age of barter—for the inhabitants of Britain to go to market, or out shopping, laden with sufficient metal for effecting their intended purchases, and to carry with them instruments for dividing, and scales and weights for weighing it. This primitive process was found to be inconvenient, uncertain, and very troublesome, and soon the expedient was resorted to of having pieces of metal cut and weighed before going out marketing. These clippings were at once the prototypes of, and the substitutes for, coins.

At length, and owing to frauds practised by buyers and sellers, both in respect of the weighing, and the debasement of the metallic symbols, it became necessary to interpose the authority of the law, and thus to regulate and systematize the rude and unshapely currency. Then appeared stamps or impressions, emblems of that authority, and guarantees of the weight and fineness of the metallic dumps upon which they were imprinted. To these marks of genuineness were subsequently added the names of the authorized moneyers by whom they were struck or stamped. The next step in the march of improvement was to decorate—as well as the artists of the day could accomplish that operation—the pieces of metal with representations of the monarch, prince, or prelate under whose sanction they were issued. Dates, legends, and inscriptions followed in process of time, but, as has been shown, the accurate sizing or weighing of the metals was always a subject of grave consideration.

Without pushing historical research further into the misty atmosphere of the far-off past, it may be stated that every Act of Parliament since the Parliamentary institution itself came into being, and every Royal Proclamation passed and promulgated in England, for the purpose of legalizing coins of the realm, has defined with great precision, though sometimes rather verbosely, the standard weight, and the standard degree of fineness, of each denomination of such coins. The law makers and the monarch of the kingdom have, however, invariably recognized the impossibility of producing coins in large quantities of the precise legal standards of weight and of fineness. A certain variation above and below those standards has always been permitted, and this specifically as a "remedy" for imperfection of workmanship. All Acts of Parliament and other legal documents having reference to the manufacture of money, are explicit as to the limits of this remedy. The gradual improvements effected from time to time in minting machinery and appliances, and increasing chemical knowledge, have allowed of the periodical reduction of the remedy, and it would no doubt be curious to trace out and note the changes and modifications which have at various epochs been effected in this direction. At present such is not the purpose we have in view, interesting and instructive as the results of such a search might prove. It must suffice, therefore, to say that, notwithstanding all the mechanical and other advantages which the existing Royal Mint possesses over mints of the olden time, it has not been able to dispense with a "remedy" for imperfection of workmanship.

The varying density of the metals used in the manufacture of coins is one substantial reason why perfect uniformity in the weight of individual pieces cannot be obtained. The machinery of that establishment is throughout excellent, and millions of planchets of gold and of silver are continually being yielded by it, which, if measured individually by means of the finest micrometer gauge, would not exhibit the most infinitesimal difference of size. Placed in a delicately-poised balance, they would, on the contrary, display material differences; some would be found above, and others below, the strictly legal and true standard weight.

Absolute uniformity of weight among coins is a "Will-o'-the wisp," which no one who understands anything of the art of coining would think of pursuing. The mere clasping of a disc of gold between the thumb and finger on a summer's day will alter the weight of that disc, as the test balances of the Mint bear evidence, and changes of temperature will produce a similar result.

It is not essential to examine further into the minute and

almost occult causes which affect the weight of coins; inequalities will exist between planchets of gold and silver though cut mathematically of the same dimensions, and all that can be done is to minimize the variations. Probably this object has been accomplished more completely in the British Mint than in any other mint in the world, and the legal "remedy" for imperfect manipulation is smaller there than in any other existing money manufactory.

The standard of fineness is a point to which reference has been made, and upon which it may be well to add a few further observations. A parallel difficulty exists in obtaining uniformity in this direction. Standard gold should contain twenty-two parts of fine gold and two parts of alloy. The mixture is made at the Mint with scrupulous care; but, in spite of this, the assayer on testing the resulting planchets will find diversity of quality. The law allows and legalizes this diversity, to a very limited extent it is true, but it does allow it. Sovereigns and half sovereigns issued from the Tower Hill establishment are sought after and used by the jewellers of all nations in the manufacture of trinkets, for they are aware that there is more certainty of those pieces of money being very near to standard than there is of the gold coins of any other country. Hence they know precisely how much alloy to add to molten coins, in order to reduce the mass to the low standard of jeweller's gold. Thus, in both a mechanical and chemical sense, it may be fairly asserted that the Royal Mint is in advance of all other mints.

It is to its mechanical excellence that we desire more especially to attract the attention of our readers; and, as we commenced by observing, this is nowhere more convincingly illustrated than in the fitments of the weighing-room. The weighing balances reject all planchets which are "out of remedy," that is, all which are above or below the lines of variation drawn by legal enactment, and they accept for coinage all that are within those lines. Before advancing to the description of their mode of action in achieving this desideratum, we shall introduce in a tabulated form the standard weight, the legal maximum weight, the legal minimum weight, the "remedy," and the dimensions of every denomination of coin circulating in Great Britain and the principal colonies. Such a table, which is given in the following page, will, it is hoped, be of practical value, as it will certainly conduce to a clearer conception of the ingeniously constructed automaton balances, and of the nature of their almost judicial offices:—

Tabular View of Weights and Dimensions of British Coins.

GOLD COINS.

Denomination of Coin.	Standard weight.	Legal max. weight.	Legal min. weight.	Legal 'remedy.'	Diam. of coin.	Thickness of coin.
	grs. pts.	grs. pts.	grs. pts.	grs. pts.	inches.	inches.
Sovereign	123·274	123·531	123·017	0·256	0·875	0·0476
Half-sovereign	61·637	61·765	61·508	0·128	0 755	0·0812

SILVER COINS.*

Denomination of Coin.	Standard weight.	Legal max. weight.	Legal min. weight.	Legal 'remedy.'	Diam. of coin.	Thickness of coin.
	grs. pts.	grs. pts.	grs. pts.	grs. pts.	inches.	inches.
Florin	174·545	175·272	173·818	0·727	1·166	0·0625
Shilling	87·272	87·636	86·909	0·363	0·916	0·0500
Sixpence	43·636	43·818	43·454	0·181	0·755	0·0370
Threepence	21·818	21·909	21·727	0·090	0·666	0·0270
Twopence (Maundy)	14·545	14·606	14·484	0 060	0·546	0·0230
Penny („)	7·272	7·303	7·242	0·030	0·422	0·0202

BRONZE COINS.

Denomination of Coin.	Standard weight.	Legal max. weight.	Legal min. weight.	Legal 'remedy.'	Diam. of coin.	Thickness of coin.
	grs. pts.	grs. pts.	grs. pts.	grs. pts.	inches.	inches.
Penny	145·833	148·749	142·916	2·916	1·200	0·0555
Halfpenny	87·500	89·250	85·750	1·750	1·000	0·0512
Farthing	43·750	44·626	42·675	0·075	0·800	0·0384

To the foregoing tables, which deal with the whole of the coinage of Great Britain as at present issued from the Mint, it may not be improper to append similar particulars in reference to the copper coins, which are fast disappearing from circulation. A comparison between the new bronze and the old copper pieces of money, of which such a course permits, the institution will exhibit palpably the economy of metal in the constitution of the former :—

OLD COPPER COINAGE.

Denomination of Coin.	Standard weight.	Legal max. weight.	Legal min. weight.	Legal 'remedy.'	Diam. of coin.	Thickness of coin.
	grs. pts.	grs. pts.	grs. pts.	grs. pts.	inches.	inches.
Penny	291·666	298·958	284·375	7·291	1·333	0·0937
Halfpenny	145·0 3	149·479	142·187	3·645	1·104	0 0731
Farthing	72·916	74·739	71·093	1·822	0·875	0·0555

* Crowns, half-crowns, and groats, are omitted from this list, because none have been struck at the Mint for many years past, and they may therefore be deemed obsolete.

It will be observed that the legal remedy allowed upon gold coins is very small, that that upon silver coins is somewhat larger, whilst the legal remedy upon bronze and copper money permits a rather wide range above and below the actual standard. The rule at the Mint, however, in each case, is to divide the actual differences as nearly equally as possible between the two extremes. The result is that, on large quantities of coin, a theoretical standard is attained. Silver and bronze coins are merely tokens of value, and individual variations between the particular coins of each respective denomination are of comparatively little consequence. With regard to gold the matter is differently based. The sovereign and the half-sovereign are intrinsically and nominally of the same respective value that their names imply, and they cease to become legal tenders when by abrasion they fall below a certain weight. The weight at which the sovereign may be refused by the Bank of England is grs. 122·500 pts. Thus the allowance for the wear and tear of circulation below the minimum weight of grs. 123·017 pts. at which it may have been issued from the Mint is ·517, or little more than half a grain. The lowest point of weight at which a half-sovereign ceases to be a legal tender is grs. 61·255 pts., its minimum weight at the Mint having been, as shown above, grs. 61·508 pts. It is not often that the Bank or any individual is so scrupulously exact as to draw the line of demarcation at the precise points indicated, though the law would justify such a proceeding.

Having thus endeavoured to explain the origin and to demonstrate the importance of the weighing operation in the art of coining, we may proceed further to state that, prior to the year 1851, the whole of the gold and silver planchets produced at the Royal Mint were weighed by workmen employed there, and known as "sizers." These occupied a large room in the establishment, from which currents of air which might disturb their balances were carefully excluded, and they were each supplied with a tiny pair of scales and weights, resembling somewhat those used by the chemist and druggist in the dispensation of their "medicinal gums." To each sizer was apportioned a certain quantity of planchets, and he became the arbiter of their destiny. The "too heavy" pieces were thrown on one side, to be reduced in some cases by filing, and then re-weighed, and the "too light" pieces on the other side, for relegation to the melting-house. The medium planchets were passed into a receptacle placed near at hand to catch them. Constant practice induced among the sizers a certain amount of accuracy in their operations. But, towards the close of a day's work it not unfrequently happened that their eyes and fingers grew tired of watching and moving, and a reckless admixture

of "too heavy," "too light," and "medium" planchets was the consequence.

In 1851 the knell of this imperfect system of weighing was sounded. The Company of Moneyers, who had long enjoyed the profitable privilege of coining the moneys of the realm, and who traced the existence of predecessors filling similar posts back to the days of the Heptarchy—fell, under the pressure of a Royal Commission, and were pensioned off. The Mint thus came entirely into the hands of the Government. Sir John Herschel was appointed Master, and Captain Harness, R.E. (now Colonel, C.B.), Deputy Master of the Mint, and the last-named gentleman employed himself energetically and skilfully in re-organizing the establishment on a new footing. Two clerks and two mechanics were appointed to succeed in the performance of the duties, though, unfortunately for themselves, not to anything resembling the emoluments of the Moneyers, and in November, 1851, the first coinage of gold under the Government *régime* commenced. Several millions of sovereigns were struck by the following Christmas, and very soon the new Moneyers, as they may be termed, became masters of their work. Captain Harness was not long in discovering the fallibility of the mode of sizing which had been for many centuries before pursued; and, as Mr. Cotton, of the Bank of England, aided by the mechanical genius of Mr. James Napier, had already devised and patented an automaton balance for the detection and rejection of light gold, the Captain determined, if possible, to make the apparatus available for minting purposes, and thus to supersede the time-honoured, but very inadequate and unsatisfactory practice of hand-weighing. Mr. Napier was consulted, and that eminent mechanist was not long in realizing the aspirations of Captain Harness. In a few months several automaton balances were prepared for the Mint. It was essential that these should be so constructed as that they should be capable of separating the light and heavy planchets from those which were of the medium weight, and it will be at once understood, therefore, that this exigency demanded further complexity in the machines than was apparent in the Bank automatons. The Bank had no objection to too heavy coins; their dislike was simply confined to those which were too light, and their machines had only to reject such as "when weighed in the balance" were "found wanting." Mr. Napier solved the more difficult problem in the manufacture of the automatons for the Royal Mint. Experiments in his own factory in the first instance enabled him to do this, and when the machines were transferred to the Mint, they were accordingly found to perform their onerous and delicate functions with unerring exactitude. It became a question of some moment as to what part of the

establishment the new and silent, but most efficient coiners' assistants should occupy on their arrival at Tower Hill. Above all things it was important that they should be undisturbed in their vocation by the tremor or vibration of the powerful steam engines and ponderous machinery engaged in the reduction of bar gold into planchets, or by the heavy and continuous beatings of the coining-presses, which finally converted those planchets into coin. A large room, on the basement story of the Coining Department buildings, and which had been used as a kind of gigantic "what-not," or magazine for the reception of odds and ends of every kind, by the Moneyers, appeared to offer peculiar attractions, and finally the marine stores within it—the accumulations of half-a-century nearly—were displaced and disposed of in order to make way for the incoming tenants. The room was lofty, large, and light; and, singularly enough, it was situated immediately beneath the old sizing-room, the operations of which the automatons were intended to supersede. A short time sufficed to effect a marvellous transformation in the internal aspect of the future weighing-room. Its dingy and dirty walls and ceilings, covered by spiders' webs and honeycombed by age, were cleansed and renovated. A longitudinal trench of considerable depth was dug in it, and this afterwards filled in with concrete and stone, served as a foundation for the weighing balances. So far as isolation of position was concerned, this arrangement was perfect, and a line of low cast-iron tables—rather too low, perhaps, for the convenience of the attendants—was speedily implanted on the solid foundation. These tables, planed on their upper surfaces, which were made to a "dead level," were not long unoccupied. The automatons, in plate-glass and brass frames, soon glistened upon the tables, and, at a first glance, reminded one forcibly of as many skeleton drawing-room clocks arranged for inspection or sale. In order to communicate motion to them, a line of small bright wrought-iron shafting, supported by neat pendants of cast-iron attached to the ceiling, and upon which were hung brass three-motion pulleys, was made to span the length of the room. The shafting was immediately and high above the line of machines, and fine gut bands, passing over its pulleys, descended to corresponding pulleys on the main driving spindles of the automatons. The lower series of pulleys were immediately outside the machine cases through holes in which the spindles ran, and a small brass weight, lever, and friction wheels were so attached as to tighten the bands sufficiently to give constant motion to the coin-feeding slides, etc., of the tiny contrivances within. A series of thumb-screws were added, for the application of pressure great enough to stop the action of

each machine at a moment's notice. The withdrawal of the pressure permitted them to resume their duties at the same brief notice.

In a remote corner of the room was placed the direct, though in itself secondary, motive power—a small atmospheric engine. This was constructed so as to resemble very closely a high-pressure steam engine. It had cylinder, piston, slides, fly-wheel, and governor. Beneath the cylinder, and forming its bed-plate indeed, was a vacuum-chamber of considerable dimensions. This could be exhausted by an air-pump, with which a two-inch pipe connected it; whilst the extent of rarefaction within it was made controllable by means of a steelyard relief-valve, and a barometer-gauge placed on the exhaust-pipe. The air-pump was the same which gave motion to the pneumatic apparatus of the coining-presses. It was on the double-acting principle—that is, it exhausted in both up and down strokes, and had many peculiarities to distinguish it from ordinary air-pumps. The writer may fairly take some credit for its invention and introduction to the Royal Mint. Returning to the atmospheric motor of the automatom weighing balances, it must be further said that when its vacuum-chamber was exhausted, and the opening of a cock in the exhaust-pipe caused it instantaneously to be so, it was only necessary further to move the fly-wheel slightly (so as to turn the crank of the engine past the centre) in order to put it in motion. A stream of air from the room rushed immediately through a small brass tube, having a trumpet-mouth, into the cylinder, and acted upon the piston, as steam from the boiler in an ordinary engine would act. Fastened to the arms of the fly-wheel was a pulley, and a strap from this passing round a similar pulley gave motion to the overhead shaft.

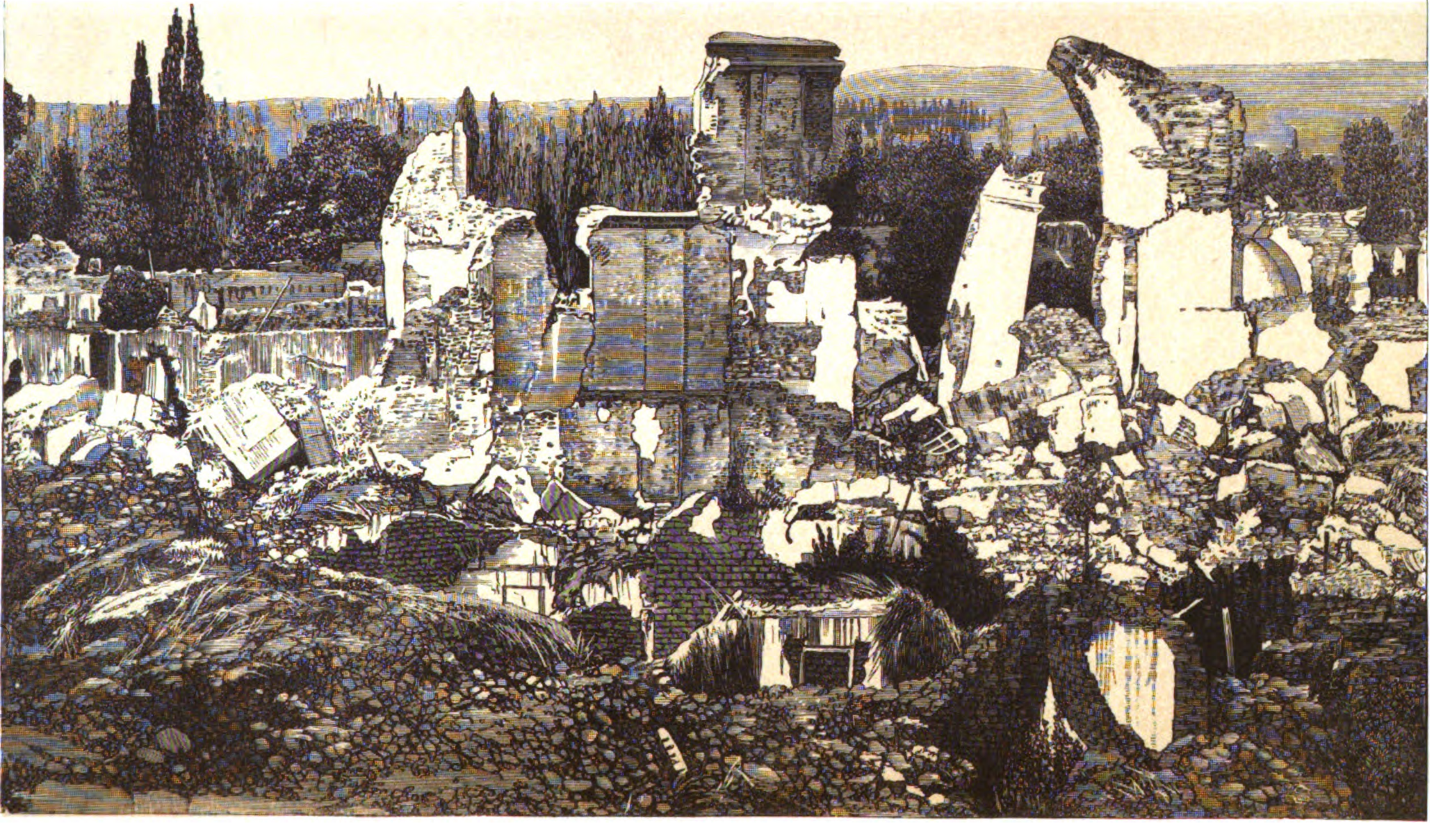
We have gone thus minutely into a description of the propelling arrangements of the weighing balances, because they are unique, and they combine perfect isolation with perfect regularity of motion. The varying speed of the general machinery of the establishment cannot affect that of the atmospheric engine and the shafting it drives, because a uniform vacuum is preserved in the vacuum-chamber of the former, and the air exerts a constant pressure on its piston. This uniformity is a *sine qua non* for correct weighing. As the mind of a judge in a court of justice must, if his decisions are to be just, be unswayed by passion or prejudice, so must the mute judges of the Mint planchets of gold or silver be undisturbed in their action, if their sentences are to be truthful and worthy confirmation. We have said that the law of gravitation is infallible; it is so, but it must be allowed fair play and perfect freedom to ensure infallibility. In the Mint balances it is the ruling power, but

that power must not be tampered with. Balances must not be hurried in their movements. It is said that those who think twice before they speak once, will speak twice the better for it; but certainly the balance which is allowed due time for acting will yield far more truthful results than that which is not. One of the great principles of the automaton, therefore, is deliberation, the other, regularity of motion. Let us now proceed to show how mechanical arrangements give practical force to both principles.

We will imagine that a large number—say 10,000 ounces weight, for example—of sovereign planchets have reached the weighing-room. They are first weighed in bulk, because it is necessary that a check should exist upon the few workpeople who are to be entrusted with the task of feeding the automatons, and then commences their distribution among the machines, each of which is supplied with a brass spout, twenty inches long, and placed at an angle. In these spouts roleaux of planchets are carefully deposited, the lowest planchet in each case resting on the top of the machine, and the others supported in regular order, planchet upon planchet, above it. Now, therefore, all is ready for action, and the automatons simply require that a small coupling upon each of their main spindles shall, by the pressure of the thumb and finger of an attendant, be made to revolve with the loose pulleys upon them. Possibly it may simplify and render more intelligible our description if we single out one balance for illustration; and here it may be also said that the whole theory of the automatic weighing machines depends upon the fact that the centre of gravity and the centre of action of its beam are in one line, or on one level. Either centre being disturbed, the balance will be no longer equal. The beam, which is of well-tempered steel, is 8·90 inches in length, and weighs 288·41 Troy grains. Its knife edges find their own resting-places upon curved loops of steel beneath them, and as the points of contact are small, the friction is minimized. The beam is supported immediately below the feeding-spout or hopper, and is preserved from dust by being covered with a brass plate. Above the upper part of one end of the beam—that immediately in advance of the foot of the hopper—is seen a flat disc of polished steel, slightly larger in diameter than a sovereign planchet. This is in fact the scale-pan, and it forms the upper part of a fine steel rod, delicately poised, and readily moved by, or moving the beam. Above the opposite end of the beam depends another steel rod, and this, finishing with a cage at the base of the machine, carries a glass counterpoise of the minimum legal weight of a sovereign. Below the cage, but not attached to it, is a "stirrup," in which rests a piece of platinum wire of the

precise weight of the legal difference or remedy allowed between sovereigns as a compensation for imperfection of workmanship—namely, the 514th part of a grain. Supposing, now, the machine to be started, the first action is that caused by a cam attached to the main spindle, and it consists in a small slide, slightly thinner than a sovereign, being pushed below the hopper, and forcing forward a planchet to the scale-pan or disc. There it rests for about three seconds, and its exact weight is, during the brief interval, noted by the automaton. If that weight exceeds the legal maximum, it depresses the end of the beam upon which it rests, and, as a consequence, raises the opposite end with its stirrup and remedy wire. The planchet is thus proved to be too heavy, and as a flattened tube vibrates below, it is pushed into this by its successor on the scale-pan—another planchet. The lower orifice of the tube passes in its vibrations over the spaces, or slots, and these lead into three compartments, known as "light," "medium," and "heavy" boxes. At the instant the too heavy planchet was dismissed into the tube, the lower mouth of the latter was held by a mechanical finger, governed by the movement of the beam, over the inner or too heavy box, and into this the rejected claimant for sovereignty falls. The next planchet may be imagined to err on the other side of the standard, and to be too light. In this case the beam will be raised by the glass counterpoise, and the tube, by the agency referred to, will conduct the condemned piece of gold into the too light box. When a medium or acceptable planchet arrives on the scale-pan, the beam will maintain a rigid equilibrium, and the succeeding planchet will push it into the tube, which having its mouth held over the central or medium slot, will conduct the accepted suitor into the medium box. In this way the automaton judges try and acquit or pass sentence of condemnation upon all the planchets submitted to their notice. They are thus constituted mute arbiters of the other mechanical operations of the Mint, and they take care at once of the public and the Mint's interests. It is not possible, so long as their intervention is secured, for light sovereigns to pass into circulation, nor for the Master of the Mint to waste the precious material of which they are composed, by issuing heavy ones. The automatons hit the happy medium, and "hold the balance fairly" between manufacturer and consumer. Parsimony and excessive liberality are alike unknown to them; they are just, but not o'er generous.

Finally, it may be observed of the system of automatic weighing at the Mint, that it is as near perfection as possible. It is also economical in the highest degree; for though each machine employed cost a fraction over £200, they have—to use



Part of the Ruins of Mendoza, destroyed by the Earthquake of March 20, 1861.

mon expression ...
... ever ...
... by their use. ...
... automatons ...
... 200,000, ...
... five. ...
... weighed up ...
... forwarded ...
... for re-... ...
of the "... ...
...
... the process ...
...
... ...
... artistically ...
price ...
...
...
... so that ...

... EARTHQUAKE AT M...

BY ...

...

... indebted to ... friend ...
... in May, ...
... devastation ...
... on the 20th March, ...
...
... Ocho...
... hours ...
... interesting and ...
... letter from the ...
... acceptable to English readers; ...
... I will ...
... city and province of Mendoza, ...
... complete by citations from other ...
... the disaster.

Mendoza is situated ...
... above the level of the sea, ...

* See *A Mining ...* ... Mining Districts of San ... and Mendoza ... etc.—*Smith, Elder, & Co.*, ...

a common expression well understood—paid for themselves over and over again in the saving of wages and of gold effected by their use. The maximum number of planchets which the automatons can satisfactorily "dispose of" in a day amounts to 200,000, and the average per cent. of rejected may be set down at five. At the close of each day the whole proceeds are weighed up in bulk—the good planchets being afterwards forwarded for stamping, and the bad returned to the crucible for re-melting. An attempt has been made to save some of the "too heavy," as brands from the burning, by filing and scraping their edges in a noisy machine; but the value of the process is questionable. If their *surfaces* could be touched in a discriminating way by means of a file, or cutter, the case might be different. As it is, the coins are likely to suffer artistically by the use of the scraper, and this is an undue price to be paid for a problematical advantage. We give at p. 73 an illustration representing one of the Automaton Balances of the Mint, the artist having removed a portion of the "case" so that the "works" may be the better seen.

THE EARTHQUAKE AT MENDOZA, 20TH MARCH, 1861.

BY WM. BOLLAERT.

(*With a Tinted Plate.*)

I AM indebted to my friend Major Rickard,* who visited Mendoza in May, 1862, for the admirable photographic view of the devastation occasioned by the dreadful earthquake which occurred on the 20th March, 1861, and which is excellently shown in the annexed plate, and also for a remarkable letter written by Don Domingo de Oro, a gentleman who was buried for five hours beneath the ruins of the city, and containing many interesting and hitherto unpublished facts. I have translated this letter from the original Spanish, believing that it would be acceptable to English readers; but before introducing Don Domingo's terrible recital, I will offer a few remarks relative to the city and province of Mendoza, and make the narrative more complete by citations from other letters written from the scene of the disaster.

Mendoza is situated in 32° 52′ S. lat., 69° 6′ W. long., 4891 feet above the level of the sea, and at the eastern foot of the

* See *A Mining Journey across the Great Andes*, with Explorations in the Silver Mining Districts of San Juan and Mendoza, by Major F. J. Rickard, F.G.S., etc. etc.—*Smith, Elder, & Co.*, 1863.

Great Andes. It is shut out from any view of the Cordillera by a range of lower mountains which intervene. The appearance of the city before the earthquake was neat and cheerful, the houses of one story, with porticoes, mostly built of *adobes,* a sun-dried brick, plastered and whitewashed, and the streets laid out at right angles. Its *Alameda* or public walk was equal to anything of the kind in South America, being nearly a mile in length, nicely kept, and shaded by rows of magnificent poplars, or *alamos,* from which its name.

The climate is delightful and salubrious, although *goitre* affects a few. The population of the city before its destruction was some 16,000 souls, about one-third of that of the whole province. The Province of Mendoza occupies a space of 150 miles N. and S., along the eastern side of the Cordillera of the Andes, and about as much E. and W. It produces wine, brandy, raisins, figs, wheat, flour, hides, tallow, soap, etc. Of its mines, those of silver at Uspallata are important; and among its mineral products are reckoned, copper, limestone, gypsum, alum, mineral pitch, bituminous shales, coal (probably tertiary), slates, fire-clays, saline deposits, including, it is said, nitrate and sulphate of soda, and indications of borax.

In the Andean region of this province, in a N.W. direction from Mendoza, is the volcano of Aconcagua, more than 23,000 feet above the sea; that of Tupungato, to the S.W.; that of Maipu, to S.S.W. (15,000 feet); and that of Peteroa, S. of the Maipu.

Having thus made the reader acquainted with the locality, I will leave the following extracts from letters to tell the story of the disaster:—

"Mendoza, *March 22nd,* 1861.

"This city was visited by an awful earthquake, at 8·45 P.M. the evening of the 20th inst. In seven or eight seconds the whole city and habitations in the vicinity were in ruins, beneath which disappeared about two-thirds of the population, say 12,000. I assisted to save Don F. Garfia, who had been *ten* hours buried under ruins, two yards in depth."

Another person writes on same date:—"I have only lost two of my children and the nurse. My wife and the rest of the family were buried for a time, but we got them out, they are much hurt."

On the 24th, another letter says:—"At 8·45 P.M., the Teremoto or severe earthquake took place. In a moment, three-fourths of the city was in ruins; the greater portion of the inhabitants are victims. The 21st, 22nd, and 23rd, the shocks continued at intervals, when the remainder of the houses fell. The few inhabitants left alive are doing their best to search for and rescue the buried ones.

"The earthquake movement came from south and east, and was impelled to north and west; these movements continuing about five or six seconds. This once smiling city is now level with the plain. Although I was wounded by the falling of a wall, I exerted myself in the hope of assisting others. I heard groans and calling for help from beneath me at every step. Some, who appeared to have lost their senses, screamed for their fathers, mothers, brothers, sisters, wives, husbands, children and friends. Men, women, and children were dragging at the robes of a priest, praying for absolution. I saw heaps of mutilated fellow-creatures, I heard their dying and despairing groans.

"In a few days I fear the few who have been spared will become victims to the knife of the assassin-robbers. Putrefaction of the dead bodies has commenced, and we have but little food.

"Just after the great shock, I went to the public walk, where I beheld a group praying round a monk, who instead of comforting assured them that flames and burning sulphur would soon consume them, beseeching all to repent and pray. This was not my opinion; I urged the desponding party to be up and doing in aid of those who were buried amongst the ruins. My friends P—— and C—— had been buried alive for an hour, whilst striving to save a child, and, although separated, could converse freely. 'I fear we are lost,' said P——. 'I believe we are,' replied C——. 'Had we not better try to sleep, and so not feel the agonies of death?' 'Perhaps we had better do so. Farewell, farewell! Should you be saved, say to my mother that in my last moments I thought of her. I will do the same for you, if I am preserved. Farewell!' 'Dear friend, I am choking with the dust; more walls are falling on us; I am getting squeezed more and more down to the earth. Let us alternately cry for help. Hark! I hear footsteps above us.' In truth, B—— had arrived, and heard the voice of his son, C——. Digging was commenced; but ere the two friends were got at, C—— had died. Many such scenes occurred throughout the ruins. Our friend Urizar was buried for ten hours. S—— was half an hour below ground; his position was discovered by his dog 'Othello.' Muñoz was saved by falling under his horse. We hear from San Juan (some 50 leagues to the N. of Mendoza) that the town has suffered much; the river there has left its bed, and inundated the city. To the S. and E. the earthquake effects have been less. About a hundred years since Mendoza suffered very considerably from an earthquake, which is known as the Teremoto of Santa Rita."

Seven or eight months before this present earthquake, at a

distance of four or five leagues from Mendoza, there were movements of the land sufficient to displace trees; there were openings in the ground from which came out sulphurous and saline matters. Two nights before the earthquake, at same spot, the ground rose and fell.

The great movements of the earthquake were from S.W. to N.E., and then from N.E. to S.W., the ground opening in many places. It was not preceded by noise or rumbling. The ground seemed to rise or swell up. Twelve miles from the city the ground opened in a S.E. and N.W. direction for more than three miles in length, and in places two and a half *cuadras* (375 yards) wide, and saline waters were thrown out. On the night of the earthquake, shocks occurred at intervals of five or six minutes, up to the sixth day. On the eighth day they were more frequent, then diminished in number again. The shocks were accompanied by sounds like the firing of cannon. Under Mendoza there seems to be a large hollow, and people have an idea that there is much water in it. It is said that a nun was got out alive after eight days' burial, but she died shortly afterwards.

It was reported that a French watchmaker in Buenos Ayres (which is about 550 geographical miles a little S.E. from Mendoza*) observed the pendulum of his clocks much affected at about 9 P.M. on the night of the earthquake.

On the 29th March, 1861, Mr. R. F. Budge, of Valparaiso, communicated to the writer of this paper as follows, on the subject of the Mendoza earthquake: "I noted in my catalogue of earthquakes this one, not from the strength of it here on the 20th inst., at 8.35† P.M., but from its duration, which led me to believe that we should soon hear of a dreadful catastrophe at some distant place in Chile. On the 25th an express arrived from Mendoza, announcing that it had been totally ruined, the great shock having occurred there at 8.45 P.M., lasting less than a minute, which was the time I noted here. Two pendulum clocks, beating N. and S., stopped."

Since March, 1861, occasional shocks have been experienced at Mendoza. In a Buenos Ayrean paper of January, 1863, it is stated that Mendoza was lately visited by rather a severe series of shocks. The new town, rising out of the ruins of 1861, is constructed of wood.

I will now give the translation of a letter of Don Domingo de Oro, which is a very remarkable record of the thoughts and feelings of a man buried alive for more than five hours:—

* Hence it would seem that the undulation took fifteen minutes to travel 550 geographical miles.

† In this instance, 140 geographical miles in ten minutes. In the one case, it travelled along the Pampas of Buenos Ayres; in the other, through the Andes.

"To Major F. I. Rickard, Inspector-General of Mines, etc., etc.

"Buenos Ayres, *December* 13, 1862.

"My dear Sir,—In conformity with my promise, I will try to narrate to you my impressions as well as my reflections on the subject of the horrible night of the 20th March, 1861, in Mendoza. I will do my best to give you an account, in the plainest terms possible, of one of the most dreadful occurrences on record.

"It was about a quarter to nine at night. I was at the house of Don Meliton Arroyo, in an apartment near to the street, in company with my relative, Pedro Zavalla. The house was in the 'Calle del Cormercio,' a cuadra and a half (225 varas) from the public promenade. I was standing, and about to proceed for my customary evening walk, when there was heard a loud cracking in the roof of the house. The rumbling sound which generally precedes an earthquake was heard in the city, but not by us; still we felt perfectly satisfied as to the cause of the creaking in the roof of the house, and Zavalla cried out 'Temblor,' or earthquake; 'and a strong one too,' I exclaimed, running towards the door, so as to get into the street; and a few quick steps brought me there, when I passed onwards towards the promenade.

"The upper portion of the house of Arroyo, which was of one story, bulged out and fell to the ground to my left, a little in advance of me. At this moment I lost the hope of being able to arrive at the nearest intersection of the streets, at which point I thought to escape and save my life. At times it happens that one gives utterance to one's thoughts, or we think aloud; so I went onwards, repeating, 'it is impossible to be saved,' when, as if to confirm my words, I received a violent blow from behind, which struck the upper part of my right leg, when I was thrown with my face to the ground, and my arms extended. I felt at the same moment that I was being covered up with weighty earthy matters, and was stretched out on the path. A second afterwards I heard the noise of heavy bodies falling, some of which increased the weight of materials above me. Shortly I heard a terrible and prolonged noise, one of the effects of a severe earthquake shake.

"I had not lost the use of my senses in any way, but the idea rushed upon me that the whole city was in ruins. Although the weight above me was very great, and my face forced down upon the path, I could breathe sufficiently to prevent suffocation. As I felt no acute pain in any part of my body, I thought I was not wounded, and that above me the layer of ruins might not be very thick. I now tried to move my legs

and arms, but this I could not do, for I was part and parcel, as it were, of the solid material in which I was buried. I had no doubt but that my last hour was near at hand.

"I now heard a human voice; it was that of my poor friend Zavalla, beseeching assistance. He had followed me, and had participated in my fate; but he was in a much more lamentable position. I did my best to cry out to him not to waste his breath, except when he heard any one walking above him, and then to make all possible offers to any one who would assist to extricate him from his living tomb. He replied to me; and then I heard him at intervals utter unconnected words, then inarticulate sounds, by which I supposed he must be in the agonies of death, and then followed an eternal silence, as far as my poor friend Zavalla was concerned.

"My reflections now became painful indeed. Subterranean noises were heard, and shakings of the earth were felt. I at times supposed the spot in which I was buried would sink into an abyss, or that the crater of a volcano would burst out there. I knew that in such like earthquakes destructive fires were known to break out, and that there might be one near to me; that the great *acequia*, or watercourse, in the public promenade might be obstructed by ruins, its waters would run over, and so get amongst and under the ruins, in which case I should be drowned within my sepulchre. Admitting that nothing of this occurred, to whom was I to look for help? My friends in Mendoza were few, and some of them, like myself, were doubtless in a similar position; others would have themselves and families to look after; then, in such circumstances would people think of their friends before their relatives? if they did, how were they to divine where I was? If people were looking for me, how was I to make my position known? for although my friend Zavalla had heard my voice, and I had heard his, this was no proof that I should be heard through the now increased mass of ruins that covered me. It seemed that my salvation in this life was impossible, and I resigned myself to the decrees of Providence. Then I wished that the waters would come and drown me, so as to shorten the period of my misery; and I even recollected to have read that miserable slaves had abridged their lives by swallowing their own tongues, and was decided upon attempting it if I found fire or water approach me, as this was the only means at my disposal.

"Although it was afterwards discovered that I had a broken bone, and many wounds, I did not suffer any bodily pain, excepting from the weight of stuff above me, heat, and insufficient respiration. I was indeed very sad, but not dejected, and I prepared myself to separate from life without becoming desperate. The thought that made me most miserable was the

probability I should die of starvation, when my life of agony would be prolonged.

"Thus passed two long, long hours. Hope indeed fought with my drooping spirit. I am neither devout, nor am I impious. I did not turn to God and beg for a life that appeared to me to be quite out of the order of nature to grant, but I did submit myself to his decrees; and considering myself as a mortal who was going in robust life to the gates of eternity, I did all I could to calmly contemplate my frightful situation, which I may call that of a living corpse.

"After a time I heard a conversation between two men; one said, seeing that it was impossible to advance in that direction with a carriage, he would leave it there and take the horses away. In a moment it came to my recollection that on the previous day I had been taken in a hired vehicle to a country house in the vicinity of the city, and I believed the voice I heard was that of the same coachman who drove me, which same man had been rather talkative during that ride, and that he had indirectly asked my name, and said he believed that he had seen me in Copiapo.

"I shouted out as well as I could several times, in the hope they would hear me, which they did at last. When they replied, I besecched them to succour me, telling them that although I was covered by a great weight of ruins, I was unhurt (which I then believed), and that I should not perish if any assistance was afforded me. At once both of them commenced to remove the rubbish that covered me.

"Lately I was so resigned, and when I had no hope of being rescued; now that it seemed I was about to be saved, I felt my spirit sink within me. The companion of the good Gonzales (for that was the name of the coachman) beginning to feel the work severe, or on account of other motives, said that he must leave off, but that he would return. Once gone, I could not believe he would ever come back; I feared Gonzales would follow his example; and as I gave myself only five or six hours more life if the weight above me was not removed, I now considered I was indeed lost. But Gonzales, as if he had divined my thoughts, called aloud, telling me not to despair; that his death alone should prevent him leaving his work of disinterring me undone.

"You know that the houses of Mendoza are built of *adobes*, or sun-dried bricks, and the mortar merely of mud, and not of lime, consequently easier to separate than burnt bricks and mortar; so that when the walls fell down, they did so in such a manner as rather to favour the removal of the ruins, even by the hands alone. My benefactor worked away for more than two hours, when he at last touched my head, and in a few

moments he exclaimed with joy, 'now take breath.' I cannot describe what feelings of gratitude I had for that generous man. He now tried to extricate me, and to put me on my feet.

"My legs were swelled in a monstrous manner and covered with wounds; I could not stand, for one had become shorter than the other. My hands, face, and head were dreadfully bruised.

"Gonzales wished to carry me to the public walk, but this he found impossible to do; so he proposed to transport me from where I was, which spot was full of deep inequalities, caused by his throwing up the ruins to get me out, but this he failed in, for where I lay I was still in peril in consequence of a ruined wall which threatened to fall with the continued earthquake movements of the earth. Gonzales at this juncture did not even know the fate of his own family, and had to leave me.

"There I was alone and unable to move. I took a glance at the scene around; how frightful it was! how horrible! The moon still shone on that huge heap of ruins, a few hours before a city of life and joy. At the distance of five or six yards from me there escaped dying groans from some ruins, which appeared to me to be those of Cesar Solar, his wife and little daughter. Farther off I heard screams and cries which went to the heart, begging for assistance; these were from Teresa Garcia, whom I afterwards saw attending the sick and wounded. Fire had broken out not far from me, and was advancing towards the direction I was laying; but, thanks to kind Providence, I was not unnerved. There were many who were actively engaged in assisting and rescuing their fellow-creatures; but there were others plundering, whatever they could lay hands on, during this awful convulsion of nature. Nicolas Villanueva passed hurriedly by in search of help to assist him to rescue his large family, whom I could hear from under the ruins, recommending themselves to God's mercy, and preparing themselves to die; the fire had now reached some combustible matters, and all around was in a blaze. There now came up to me Señor Arroyo, who told me with broken heart, ejaculating, that he had lost six of his children; still he went searching for his unfortunate friend Zavalla, in which search he rescued a poor maniac woman who was buried near to me.

"But how am I to relate to you all the frightful scenes I saw on that awful night?

"To those who passed, whom I thought able to move me, and would do so for money, I offered gold to carry me to the public promenade, which was only two hundred and fifty yards distant; but no one gave heed to me. Early in the morning Ramon Muñoz, a Chileno political emigrant, mercifully came to my assistance with a party of men, and transported me to the

promenade, where I was placed among dead, dying, and many who were sadly wounded.

"My clothes had been torn to pieces, my hat lost, and the early morn was cold. Luis Marco gave me a dressing-gown, and in this state I remained until the evening, when I was seen by Mr. Bergman, a surveyor, who had lost his wife and all his children except one; he proposed to remove me to a less disagreeable spot, where I found Mr. Civit with a broken foot, others wounded, some ladies who had lost their families; from these I received whatever assistance they could render me. I must not omit to particularize the name of a young Chileno, Señor Vieites.

"Four days I remained with this party in affliction. Up to this period such charity and kindness as could be proffered I received, when Don Tomas Garcia of Mendoza discovered me. We had known each other in Chile, and were friends, without being very intimate. Not only his house in the city, but one in the country, were destroyed on the night of the 20th of March. He had lost three of his children in the earthquake; the remaining three had been saved through the exertions of his beloved wife—he himself most miraculously; he had already built up a hut.

"However, under such appalling domestic affliction, he did not forget the sufferings of others. He had sought for me for three days, although he had been assured that I had perished. He had me borne with the tenderest care to his newly-erected hut. His good wife had prepared for me a tent out of pieces of cloth and carpet, and where I felt that Garcia and his ministering angel of a wife would take care of me.

"Her necessary household affairs were not forgotten; these being finished, she would retire for a while to pray and weep for her lost little ones, then she became a true sister of charity; never can I forget her and all her pious doings. She bathed and dressed my wounds; she gave me medicine to assuage my pains, and helped me to the food I required, with such persuasive gentleness, only to be done by tender-hearted woman; she was the personification of human goodness. I would at times call for a servant to assist me, but ere one could arrive she was at my side, night or day, ready to attend to me.

"Very shortly after the arrival of Dr. Day, Garcia brought him to me; and now the medical man took charge of my cure. Through the unremitting kindness of Garcia and his wife, and that of Dr. Day, after a period of twenty-three days, I could lay myself down; but it was three months ere I could go upon crutches, when I journeyed to San Juan.

"Years had passed that I had not shed a tear; the destruction of the city of Mendoza, and even whilst in the frightful position of being buried alive, no tear dimmed my eye; but the

day of separation from Garcia and his wife came, my heart was now moved. Still I kept a serene look; the moment for saying farewell arrived; I saw them in tears—speak they could not—but ejaculated their prayers for my restoration to health. I now felt most acutely, my heart beat rapidly; I was tongue-tied, but a flood of tears came to my relief. We embraced each other; I covered my face, and was glad indeed when the carriage was announced to convey me to San Juan.

"The spectacle of domestic life, and the love I observed in the family of Garcia, made me a better man; there I saw an example of real felicity only to be obtained by the practice of virtue, and I could not now believe that these were so exceptional as I had formerly considered. Can I ever forget Garcia, his wife, and the coachman Gonzales?

"To conclude: if there were fiends in human form, and who committed the most atrocious acts of rapine during and after the calamitous earthquake, there were also examples of heroism and goodness. A young lady who had been exhumed from the ruins, and only had her under-garment on, the moment she found herself preserved, began to work at once in the liberation of others, continuing it all that very cold night, and so scantily clothed. A poor woman (not a model of virtue) who escaped death most miraculously, and badly wounded, worked incessantly during that night of horrors, and saved at least five fellow-creatures from amongst the ruins. A good man whose habitation was without the city, but was in Mendoza when the earthquake came on, remained all night succouring the distressed, assisting to save many from an untimely grave; proposing to himself that having disinterred the one he was at work at, he would go and look after his own family; which being done, another and another scene of distress met his sight, to which he went. Kind Providence rewarded him, for at daybreak when he got to his own house, although he found it in ruins, his family was safe, but weeping for him, supposing that by his not returning during the night that he had been buried in the ruins.

"Your faithful Friend and Servant,
(Signed) "DOMINGO DE ORO."

THE MIDNIGHT SUN.

BY THOMAS W. BURR, F.R.A.S., F.C.S.

THE December number of the INTELLECTUAL OBSERVER contains a notice of a very interesting work, entitled *A Spring and Summer in Lapland,* by an "Old Bushman," which the reviewer introduces by some remarks on the influence over the imagination of those regions of the earth which lie sufficiently near the North Pole to exhibit the remarkable summer phenomenon of an unsetting sun; and proceeds to quote Longfellow's spirited lines, describing the effect on the "Ancient Mariner" who discovered the North Cape, in which lines—

> "And *southward* through the haze,
> He saw the sullen blaze
> Of the red midnight sun,"

we shall presently see there is an astronomical blunder. The book of the "Old Bushman," which is replete with the most interesting information in Natural History, also contains a vivid description of this singular appearance, and these notices have produced a shower of communications to the INTELLECTUAL OBSERVER asking an explanation, "how the sun can be seen at midnight?" Such inquiries are principally, as may be imagined, from the more juvenile readers, and in consequence of their number, the conductors of this journal, with their usual readiness to gratify laudable curiosity, and impart useful information, have requested me to give, as briefly and simply as possible, the reasons of the phenomenon and the explanation of the effects produced, which, it is trusted, will at once clear the path for the younger portion of my readers, and may also not be unacceptable to some "children of a larger growth," whose astronomy has become a little rusty.

The effect in question, it is obvious, involves a consideration of the causes both of the seasons and of the various lengths of day and night, and these are due to two peculiarities of the earth as a planet, viz., the obliquity of the equator and ecliptic, and the parallelism of the earth's axis.

Every one knows that the earth revolves round the sun in the period we call a year, and that it rotates on its axis in the time we call a day, including periods of light and darkness, which, except on two days in the year, are unequal in all parts of the earth except at the equator—the days being long and the nights short in summer, and the days short and nights long in winter, at each particular place. The two periods when the days and nights are equal all over the world, consisting of twelve hours each, are called the equinoxes, and occur about 21st March and 21st September, and were the orbit of the

earth coincident in level with the position of the sun, or, speaking astronomically, were the equator and ecliptic in the same plane, and were the axis of the earth perpendicular to the orbit, the phenomena of the equinoxes would be those of the whole year, and the temperature of each place, and the length of day and night, would always be those which it has at the dates just given. But neither of these conditions exists, the planes of the equator and ecliptic (or path of the earth round the sun, forming the sun's apparent path in the heavens) are not coincident, but inclined at an angle of 23½ degs., and the axis of the earth is therefore tilted out of the perpendicular to its orbit to the same amount. This axis also in its revolution round the sun is invariably directed to the same point in the heavens, called the Pole, which is easily distinguished by the well-known Pole Star,* and this constant direction of the axis causes an unequal exposure to the light and heat of the sun during different lengths of the day, and the obliquity of the ecliptic also causing the solar rays to fall with very different degrees of verticality on the earth at different times, produce the charming variety of the seasons. To show the importance of these arrangements, let us suppose the axis of the earth had not been inclined to that of its orbit, and mark the consequences. Under this condition every portion of the earth during the year would have the duration of the days and nights equal. The sun's rays, falling perpendicularly, would burn up the regions near the equator, and render them uninhabitable. The countries situated between the equator and high latitudes would have the temperature of a mild spring, which would be continuous, and they would be deprived of the beautiful changes of climate we enjoy; while few, if any, plants would attain maturity, rendering the existence of animals a precarious and doubtful matter. But the condition of the regions at a considerable distance from the equator or near the poles, would be very dismal; an eternal winter and continual desolation would prevail in countries where millions of human beings now live happily. Still worse would be the result of the earth's axis being placed parallel to the ecliptic—sharp alternations of day and night, heat and cold for six months at the time, would be the unpleasant fate of each hemisphere under this state of things.

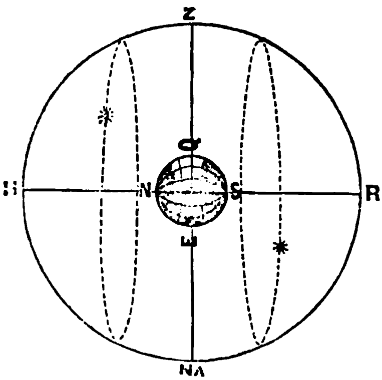
Happily for us, the axis is inclined, and has the constant direction before mentioned; and to get an idea of the result, let me ask my young friends to take an orange, as an easily obtained miniature of our globe, and passing a long needle or

* The minute variation in this direction, due to precession, is of no consequence as connected with the seasons, and does not interfere with this explanation. See the author's paper on the Precession of the Equinoxes in the INTELLECTUAL OBSERVER of June, 1863.

wire through its flattened poles, carry it steadily round a candle or lamp placed in the centre of a table, taking care to slant the wire about a fourth of the distance from the table to the ceiling, and always keeping the point in the same direction. At one part of the revolution the orange should be lifted a little above the level of the flame, and at the opposite point a little depressed. At the two opposite intermediate points only should the orange and flame be in the same plane. If we now examine the effects of the light upon the orange in its revolution, we shall get an exact representation of the sun's effect upon the earth, and to show this accurately, let us notice particularly four different positions in detail. First, if the orange be in one of the positions level with the flame, it will correspond with the earth in the northern spring, when the sun is exactly at the same distance from both poles, and affects each hemisphere alike—this being about the 21st of March; by the 23rd of June the earth (or orange) will have moved to the point in its orbit most depressed below the level of the sun (or flame), and the north pole is then nearer to the sun than the south, and the northern hemisphere receives a greater amount of heat than is received by the southern—constituting the northern summer. If we note carefully the rays of light falling on the orange, it will be seen that in this position they extend over and beyond the north pole, while the south pole remains altogether unenlightened, so that, notwithstanding the rotation of the earth on its axis, the day will be continuous at and near the north pole, while it will be constant night in the opposite regions of the south.

Proceeding with the illustration we arrive at another of the equinoctial positions, corresponding to the northern autumn, on the 21st of September, when the hemispheres are again equally lighted, and the day and night again equal. Lastly, from the 21st of September to the 21st of December, the earth progresses to her position above the plane of the sun, and the orange will then be above the level of the flame. Here the north pole is turned away from the sun, while the south pole inclines towards it; hence the northern pole and hemisphere receive a much smaller portion of light and heat than the southern, and it is therefore to us winter, while the south is enjoying its summer. It is a singular circumstance, that in consequence of the eccentricity of the earth's orbit, we are really nearer to the sun in our northern winter than in the summer, by about three millions of miles; but this is so small a space in proportion to the whole distance of the earth from the sun, and its consequences are so far outweighed by the more important results of long days and short nights, with greater verticality of rays, that its effect is immaterial.

It is, however, necessary, with reference to our especial object of explaining the Midnight Sun, to go into further detail of the unequal days and nights of different latitudes, and as some little difficulty may arise from the apparent motion of the sun in altitude, due to the earth's rising and sinking above his position, it may be desirable first to consider the apparent paths of the stars as caused by the earth's rotation on its axis, these bodies, from their distance, being free from the effect produced upon the sun's meridian altitude by the obliquity of the equator and ecliptic, and therefore not altering their declination or distance north or south from the equator. Some simple diagrams will enable us to do this most effectually. In Fig. 1 the appearance



of the heavens, as seen by an inhabitant of the earth at the equator, is indicated. In this and the two following figures the letters of reference are the same, H R being the observer's horizon; N and S the north and south poles of the earth; E Q, its equator; Z and NA, the zenith and nadir of a place. The diagram then shows that a place on the equator will have the poles in its horizon, and that all the celestial bodies will rise and set at right angles to the horizon, and will continue just as long a time above it as they do below. The dotted lines represent the paths of stars or the sun, and as the rotation of the earth on its axis is uniform in rate, the semicircle above

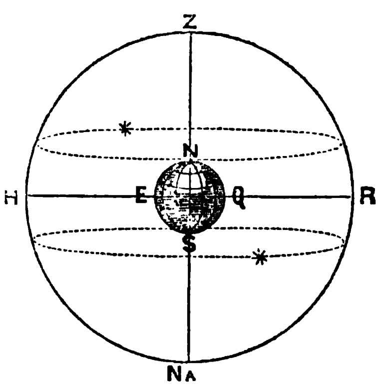


Fig. 2.

will be described in the same time as the one below, and this being twelve hours each, the days and nights will be equal throughout the year. The observer will also see the whole of the stars in the heavens, which he can do nowhere else, although some will be in very unfavourable positions. Passing to Fig. 2, a very different state of things is presented to view. Here the north pole is in the zenith, and the equator (or equinoctial, as the circle in the heavens answering to the

earth's equator, is termed) forms the horizon. The heavenly bodies, such as those stars which are visible at all, never rise or set, but may be observed during the whole of their apparent revolution, caused by the real rotation of the earth on its axis, their distance from the horizon never varying, and their motion being in circles parallel to the horizon. Stars below the equator, that is, all the stars of the southern half of the celestial vault, are never visible, while those in the northern half never disappear. The sun, for six months in the year, when his position is below the equator, or he has south declination, never rises above the horizon; while during the other six months, having north declination, he never sets, but moves round in a series of circles nearly parallel to the horizon, or, strictly speaking, in a spiral, first ascending, till on the longest day he attains an altitude of 23½ degs.; and then descending, till lost to view about the 21st of September. If the observer depart from either the pole or the equator, in the first case the pole will sink from its position over his head; and in the latter, the pole towards which he is travelling will rise. Wherever he may stop, the pole will be the same number of degrees above the horizon as the observer must use to express his latitude. To illustrate such a position Fig. 3 is drawn. The diagram represents the north pole elevated 60 degs. above the horizon, showing that to be the northern latitude of the place, and here, or indeed at any other latitude, except 0 degs. and 90 degs., all the heavenly bodies rise and set obliquely, their diurnal paths making with the horizon angles equal to the co-latitude, that is, the difference between the latitude and 90 degs.; in this case the co-latitude equals 30 degs.

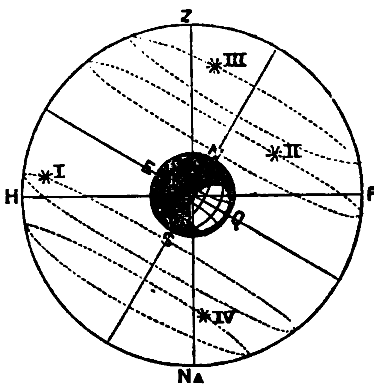


Fig. 3.

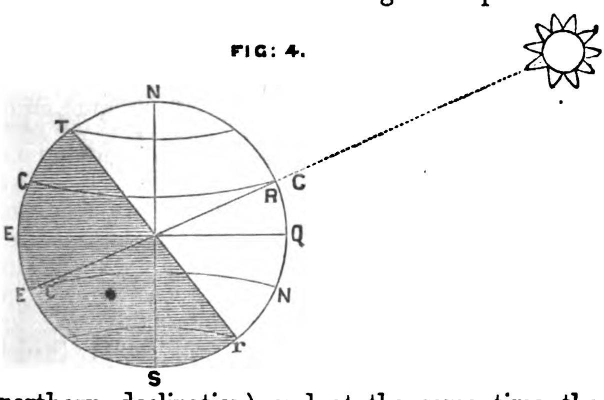
A heavenly body on the equator will have its diurnal path half above and half below the horizon, and if the body so situated be the sun, the days and nights will be equal to that place. Those bodies to the south of the equator will, in the latitude of the figure, have the greater part of their diurnal path below the horizon, and the smaller part above, as shown at I; on the contrary, those to the north of the equator have the greater part of their daily path above the horizon, and the smaller below, as at II. Now the sun varies his distance from the equator, ranging about 23½ degs. on either side of it. When

north of the equator the days will be more than twelve hours long, to an observer at 60 degs. north latitude; and when south of that circle they will be less than twelve hours. There is a circle, III, representing the path of a star which never descends below the horizon. Thus, at London, there are certain constellations, such as the Great Bear, Draco, Cassiopea, Cepheus, the Little Bear, Perseus, and others, which never set, and which are visible on every fine night throughout the year, performing their incessant revolutions round the north Pole Star as a centre. Such stars are called circumpolar, and all stars whose distance from the pole is less than the latitude of the place will be circumpolar there. Of such stars at London, Capella and those of the Great Bear form conspicuous examples, being always above the horizon, though of course requiring instrumental aid to be seen in that part of their diurnal path which is performed in daylight. Within the same distance from the depressed southern pole, will be found a number of constellations, the stars of which never rise to our observer at 60 degs. north latitude; an example is seen in the figure at IV, and many of the southern constellations are so situated with respect to us. I have been thus minute in describing the apparent paths of stars at different latitudes, because the explanation of the Midnight Sun depends upon the fact, that within the Arctic circle, that is, at a less distance than 23½ degs. from the pole, the sun becomes at midsummer circumpolar, like the stars we have so called, and while at a latitude of 66½ degs., where the circle is drawn, this happens only on the longest day; as we proceed nearer to the pole, his path becomes more parallel to the horizon, and he continues circumpolar for a longer period. The sun, in fact, seems to go round the earth in a ring, inclined to the horizon, having his greatest altitude, due south, at twelve o'clock in the day (which in Lapland would be about 47 degs.), and his lowest point just touching the northern horizon at twelve o'clock at night. Further north, the southern altitude would become less, and the northern greater; till near the pole the circle would be nearly parallel with the horizon, and could we reach the pole, entirely so. Thus, the "Old Bushman," whose quarters were at Quickiock, only just within the circle, although for about a month at midsummer he could always see the rays of the sun reflected on the northerly fells at midnight, and, in fact, for two months had the night as light as day, for reading, hunting, and shooting—had to ascend "Porti Fellen," about 5000 feet high, on June 24th, at midnight, to see the sun himself; but had he gone further north, even to the North Cape, as many travellers do, no ascent would have been necessary. It may here be remarked that Lapland is the only place which is

readily accessible by Europeans desirous of witnessing the glorious spectacle of the unsetting sun. It is also a most interesting country on other accounts. Despite its northern position, corn still grows in latitudes which elsewhere are sterile, for which it is indebted to the Gulf Stream impinging on the coast of Norway; while the luxuriance of its flora, during the short but brilliant summer, and the profusion of animal life peopling the magnificent scenery, render it well worthy a visit, and a trip to Norway is now becoming comparatively frequent. To all such intending tourists a perusal of the *Spring and Summer in Lapland* will be most essential, containing, as it does, full information for reaching either Hammerfest, near the North Cape, or Happaranda, at the head of the Gulf of Bothnia, in the best manner; while in a natural history point of view the book is invaluable.

To illustrate still more clearly the effect of increased latitude in producing continuous daylight, it will be desirable to introduce a few more diagrams. Figs. 4, 5, and 6 have the same letters of reference. Fig. 4 explains the long days and short nights of the northern summer (the sun about the 21st of June being over the Tropic of Cancer, and therefore at its greatest northern declination), and, at the same time, the short days and long nights of corresponding southern latitudes.

FIG: 4.



N S is the axis of the earth; E Q, the equator; E C, the ecliptic; C R and C N, the Tropics of Cancer and Capricorn; and T R, the line separating light and darkness, or the real horizon. At the central line of the globe, on the side turned towards the sun, it is mid-day; at the terminator, or line of shading, it is, on one side of the globe, sunrise; and on the other, sunset; while on the central line of the side in shade, it is midnight. At N, and the adjacent parts down to the Arctic circle, no portion of the globe will be carried by the diurnal rotation into darkness, and there is, therefore, continual daylight. At the Tropic of Cancer places are carried through unequal portions of the light and shaded parts, and there are long days and short nights.

At the equator the light and shaded parts are of equal extent, and the days and nights are equal, as is always the case there. At the Tropic of Capricorn, the light and shaded portions are unequal, but inversely to the Tropic of Cancer, and there are short days and long nights. At S, and adjacent to it, so far as the Antarctic circle, the earth's rotation produces no emergence out of the shaded part, and the night is therefore continuous.

FIG: 5.

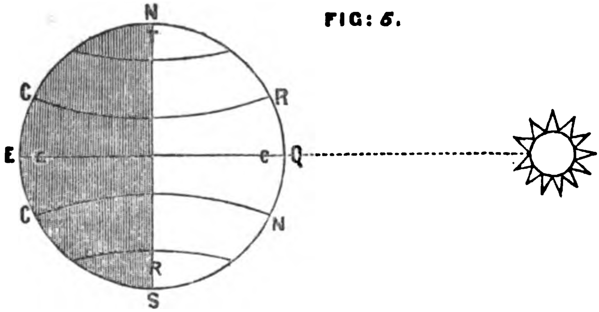


Fig. 5 represents the effect of the sun being over the equator, as he is in March and September, instead of over the Tropic of Cancer; the days and nights are then equal all over the world—the axial rotation exposing every part of the earth's surface to the same amount of light and darkness.

FIG: 6.

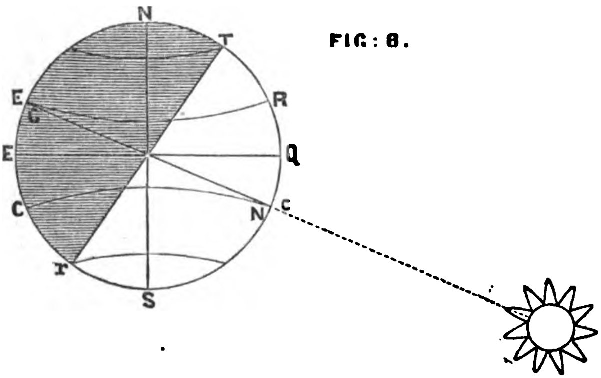


Fig. 6 shows the sun over the Tropic of Capricorn, as he is on the 21st of December, having the greatest south declination he attains, and explains the southern summer, and the short days and long nights of our winter. Here no portion of the surface included in the Antarctic circle can escape from the sun's light, and the phenomenon of the sun continually above the horizon will be witnessed by any person reaching a high southern latitude, as well as in the north, which has hitherto claimed our attention.

Let us sum up the teaching of these diagrams. To all places at the equator the days and nights are always of equal length. To all other places, except the poles, the days and nights are never equal, except at the equinoxes. To all parts of the world the days and nights are equal at the vernal and autumnal equinoxes, about the 21st of March and 23rd of September, when the sun enters the signs Aries and Libra, and has no declination.

To all places having the same latitude, the days and nights are always of equal length at the same particular time of year.

To all places north of the equator, the longest day and the shortest night are when the sun has his greatest north declination, and is on the Tropic of Cancer; and their shortest day and longest night when the sun has his greatest south declination, or is on the Tropic of Capricorn. In southern latitudes the reverse is the case.

To all places at the Arctic and Antarctic circles, when the sun has his greatest declination, he appears without setting for twenty-four hours, the length of their longest day, although the continuous daylight may last for weeks, as the sun sinks so little below the horizon that the twilight is sufficient for all purposes throughout the night. To all places within those circles the length of the longest days and nights increases the nearer the places are to the poles.

At the north pole, from the 20th of March to the 23rd of September, the sun is constantly above the horizon, and below it through the opposite interval. There is, therefore, during the whole year, but one day and one night, each of six months duration; but no one has yet reached the pole to experience this effect. In speaking of the long and dreary winter night, lasting for many months, which these illustrations show to be the lot of polar regions, we should not lose sight of the compensating influences. Thus, although the sun may be for months below the horizon, still he is rarely as much as 18 degs. lower than that circle, and therefore, owing to the existence of an atmosphere and its property of refraction, the amount of twilight is very considerable; and if we remember how strong this is during our summer, when for one month before and one after the longest day, we are said to have "no real night," the importance of this beneficial arrangement becomes manifest.* Again, the full moon is always opposite to the sun, and

* As far as 84½ degs. north latitude, the sun approaches within 18 degs. of the horizon at mid-winter, and therefore relieves the long night of three or four months, every twenty-four hours, with a short twilight. Even at the North Pole the sun is not more than 18 degs. below the horizon, till November 12th, and comes within that distance again on January 29th; the 78 days between being the only period of total night. From September 21st to November 12th, and from January 29th to March 21st, although the sun is absent, there is twilight,

as the sun is below the horizon, the moon will be for a considerable period in each month, and that before and after the full, when her light is greatest, always shining, only sinking below the horizon when in the crescent form, and giving little light. Added to these constant phenomena are the brilliant displays of Aurora, common to such latitudes, and the beauty of the icy scenery, and we may yet understand that even in these regions there is an amount of physical and intellectual enjoyment to be derived from the bounty of the Creator, who has left no district without its charms.

Such are the astronomical causes of the Midnight Sun. They may be condensed into the statement, that within the polar circles the sun becomes circumpolar, for a period increasing with the latitude; and if we pay attention to the constellations, which are so situated with respect to ourselves as to be circumpolar, and also watch how very near the sun sets to the north point of the horizon, on its western side, at midsummer, and how, in a few hours, he rises again close to the north, on the eastern side, having, as it were, only just dipped out of sight—we shall readily undertand how a journey of a few hundred miles further north may bring us to a position, where, having reached the lowest part of his apparent daily path, he begins to ascend without ever having been lost to the gaze of the observer. The only difference between the sun and stars is, that they have always the same declination, and if circumpolar at a place at all, are always so; but the sun ranges from 23½ degs. south, to 23½ degs. north; and it is only when having north declination that he can be circumpolar to any part of the northern hemisphere, and *vice versa.*

Of the actual appearance of the Midnight Sun it is hardly necessary to speak here. All my readers have seen, or will see descriptions of the effect in the books of northern travel they may come across, and these accounts vary with the temperament of the traveller. Even fiction has borrowed the phenomenon for an incident. The charming Swedish novelist, Frederika Bremer, in her tale of *The Midnight Sun,* takes her characters on a pilgrimage to the mountain of Avisaxa, in Lapland, to behold the glorious sight, which is not, however, described in detail, the authoress being more occupied with the emotions of her ideal personages than with the aspect of Nature, although the beauty of the scene is there indicated by a few graphic touches. Our "Old Bushman," in his *Spring and Summer in Lapland,* after indulging in the poetical reflections called up by the glorious scene, says:—"In the north-east, where the fells were lower, the sun shone out of an unclouded sky, apparently about a foot from the horizon's edge—an angry, sullen, lurid globe of fire, without appearing to emit a single ray

of heat, for we could stare him in the face without winking. He appeared to me to go down about due north, and, without rising or sinking,* for nearly an hour, to travel eastwards, when he gradually rose and assumed his wonted splendour." We thus see that Longfellow is in error when he represents a person looking "southward" for the Midnight Sun, as both theory and observation show it is seen in the north.

The author continues, in language which is worth quoting :—"Never did I feel my own insignificance so much as when I descended the fell, and left this grand scene behind me. Place man in cities among his finest works of art, among his manufactories and machinery; bid him jostle his way through the human crowd among whom he lives, and his lip may curl with pride and self-satisfaction as he gazes triumphantly on some master-stroke of ingenuity, or chuckles at the success of some mighty speculation. It is then that he rises, as it were, in his own estimation, superior to his fellow man, and for the moment seems almost to forget that he is mortal. But place such an one in a scene like this at the hour of midnight, and let him see if his self-pride will not receive a check! He will now be able to compare the most stupendous works of his hands with the works of Nature, and then let him strike a balance. His choicest works of art can scarcely vie in beauty with the meanest wild flower he heedlessly crushes under foot, and as for his boasted superiority over his fellow man, why, in this rude spot the little untaught Laplander is worth a dozen of him."

Perhaps one of the most unlikely places to expect the Midnight Sun to make its appearance would seem to be the pages of Thomas Carlyle, but, strangely enough, in *Sartor Resartus* he conducts his clothes philosopher, Teuflesdrockh, to the solitude of the North Cape, on a June midnight, and writes (with which we must conclude) thus :—"Silence as of death—for midnight, even in the Arctic latitudes, has its character: nothing but the granite cliffs ruddy-tinged; the peaceful gurgle of that slow, heaving polar ocean, over which, in the utmost north, the great sun hangs low and lazy, as if he, too, were slumbering. Yet is his cloud couch wrought of crimson and cloth of gold; yet does his light stream over the mirror of waters like a tremulous fire pillar, skirting downwards to the abyss, and hide itself under my feet. In such moments, solitude

* This is probably due to the effect of refraction, which, as the sun approached the dense lower strata of the atmosphere near the horizon, would tend to raise his disc very considerably, and the lower part to a greater extent than the upper. For an explanation of refraction, and any other technical astronomical terms used in this paper, the reader may consult the article on Precession previously referred to.

also is invaluable; for who would speak, or be looked on, when behind him lies all Europe and Africa, fast asleep, except the watchmen; and before him, the silent immensity, and Palace of the Eternal, whereof our sun is but a porch lamp!"

MOSSES—GRIMMIA AND SCHISTIDIUM.

BY M. G. CAMPBELL.

WHILE the "Fair Maids of February,"* the "admired of all beholders," tremble on our hedge-banks, and hang their modest heads, as if anxious to shun the gaze they cannot but attract, the elegant *Grimmia orbicularis*, or *round-fruited Grimmia*, still more worthy of regard, may be found, albeit all unnoted, spreading its dense tufts upon calcareous rocks, sometimes mixed with its cousin of more common occurrence, *Grimmia pulvinata*, or the *grey-cushioned Grimmia;* and sometimes in compact family groups, braving alone the storms of its weather-beaten home.

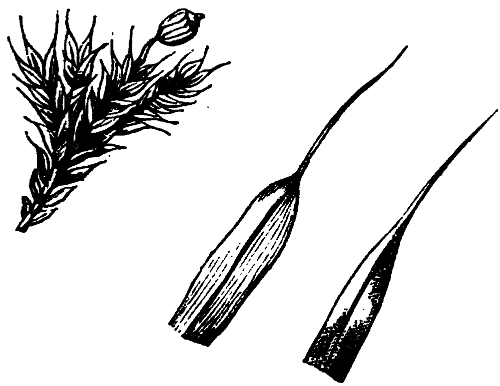
The genus named in honour of Grimm, a German botanist, consists of perennial mosses, allied at once to *Schistidium* and to *Racomitrium*. They grow upon rocks and walls, sometimes in compact tufts, sometimes loosely, and irregularly cæspitose, with capsules which vary much both in form and position, being in some species immersed and shortly pedicellate, in others, excerted, erect, cernuous, or pendulous, on a straight or on a curved pedicel, solitary, and with a mitriform calyptra reaching below the lid; sometimes five lobed at the base; sometimes dimidiate, or cloven on one side. The inflorescence is monoicous or dioicous; at first both flowers are terminal, but at length, by growth of the stem, the gemmiform barren flower becomes lateral.

The leaves are semi-amplexical and imbricated at the base, while they spread in the upper parts, and generally terminate in a longer or shorter semi-transparent white hair-point, usually denticulate; the upper leaves largest and tufted at the summit of the stem. The peristome consists of sixteen rather large lanceolate teeth, convex externally, and trabeculated; bitrifid, spreading, or sub-erect when dry; either purplish, pale red, or yellowish brown, and slightly hygroscopic. The columella instead of being deciduous and falling off with the lid, as it does in *Schistidium*, shrinks up into, and remains in, the ripe capsule, a circumstance which forms the chief difference between *Grimmia* and *Schistidium;* the latter might therefore be classed as a sub-genus of Grimmia, with a

* The Snowdrop—*Galanthus nivalis.*

columella adhering to the lid, and all its capsules sub-sessile and immersed.

Grimmia orbicularis, of which we give a magnified illustration, with stem leaves very highly magnified, grows on calcareous rocks, with densely tufted stems, and crowded oblong - lanceolate leaves, having long diaphanous points, and small dot-like cellules, in straight longitudinal lines. These cellules are, however, enlarged towards the basal margins, and as they descend the stem the leaves are less crowded, diminish in size, become destitute of the bristle, and are even somewhat obtuse pointed.



Grimmia orbicularis.

The capsule is roundish, on a pale yellow curved fruit-stalk; the capsule itself as it ripens passes from pale yellow to bright red, is smooth and glassy while recent, but obscurely striated or ribbed when dry; the walls of a rather thin or semi-opaque texture, with a narrow annulus and a very short mammillate, but never rostellate lid. The teeth of the peristome rather short and broad, trifid, sometimes quadrifid at the apex, semi-opaque, of a pale red, rather distantly marked externally with transverse bars, and much perforated or crib-rose towards the base; they are erect or converging when dry. The calyptra is dimidiate and soon falls away.

Though *Grimmia orbicularis* ripens its fruit at an earlier period, it sometimes, as we have before said, grows intermixed in the same tuft with a more common species, *Grimmia pulvinata,* or the *grey-cushioned Grimmia,* which is commonly found on walls and roofs, as well as upon rocks; it, too, grows in densely tufted round patches, with branching stems, from half an inch to an inch in height, and with leaves very much resembling those of the preceding species, being elliptic-lanceolate, suddenly attenuated and piliferous, terminating in long white hair-points, but the leaf is broader than in *orbicularis;* carinate, with a somewhat stronger nerve, which vanishes below the hair-points, and though both are hoary from their white terminal points, the foliage of *pulvinata* is of a more yellowish green; that of *orbicularis* has a bluer hue, and more dingy appearance.

But however the naked eye may be deceived, placed under the microscope the fruit at once reveals the species. The capsule of *G. pulvinata* is less round, and instead of the bright red, has a dull reddish-brown colour, with rather thick and opaque walls, eight ribbed when dry, a lid conical below, but with a straight beak about half as long as the capsule. The calyptra not dimidiate, or splitting one side, but about five-lobed at the base, and the annulus broader and compound, but quickly unrolled after the fall of the lid. The teeth of the peristome are lanceolate, deep purplish red, more or less spreading when dry, and, as in *orbicularis*, often cloven at the apex, which circumstance at one time occasioned its being confounded with the *Dicranums*.

The fruit of *G. pulvinata* is drooping, forming as it were the tasselled point of a little hook reversed, which the seta greatly resembles; or perhaps it were better to liken it to the curve at the upper end of a shepherd's crook; and it is usually concealed by the leaves when growing; it ripens in March and April.

A variety of this moss, termed *obtusa*, has been found on St. Vincent rocks, near Bristol, and on Conway Castle rock, having shorter stems, a shorter capsule on a shorter pedicel, teeth of the peristome shorter, and a sharp conical lid, obtuse, or mammillated.

Grimmia spiralis, or the *spiral-leaved Grimmia*, has also lanceolate leaves, tapering into long diaphanous hair-points, but it cannot be confounded with either of those mentioned from its slender, almost filiform stem, and its leaves being spirally imbricated or contorted round the stem when in a dry state.

It grows on dry exposed Alpine rocks; has been found on the east side of Slemish mountain, county Antrim, Ireland; on Ben Lawers, and other mountains in Breadalbane; on the Grampian mountains, and on Snowdon. Upon its native rocks it forms large dense tufts, which, however, readily fall asunder when torn from them; of somewhat fragile texture, it reaches from half an inch to one inch and a half in height, the stem more or less branched, and not unfrequently proliferous, with lateral flagelliform shoots. The upper leaves and the perichetium alone terminate in hair points; those of the stem are slightly spreading, incurved above the middle, and are somewhat recurved in the margin; the perichætial leaves longer, broader, and concave.

The capsule is small, of a pale, reddish brown, ovate or obovate in form, and having eight furrows in the dry state; less marked, almost inconspicuous when growing. The lid is short, apiculate, scarcely rostellate; the annulus compound, and

dehiscing in fragments; the teeth of the peristome rather long, of a purplish red, bifid and recurved when dry; the calyptra conico-mitriform and five-lobed at the base. The moss is, however, much oftener found without than with the fruit.

Grimmia torta, or the *twisted-leaved Grimmia*, seems like an exaggeration of *G. spiralis*, which it greatly resembles in its mode of growth; but it is a more robust species, its incoherent tufts, of a rich olive brown, rising to the height of from one to two inches. The leaves are more contorted when dry, and when they have diaphanous hair-points—a circumstance of only rare occurrence—those points, instead of being long, are very short; the leaves are also acutely carinate, and channelled along the nerve, so as to be almost conduplicate. No fruit has as yet been met with, nor any flowers observed, though the plant itself is plentiful on rocks in England, Scotland, Ireland, and Wales; but among the leaves near the top of the stem, and sometimes adhering to the back of a leaf, are frequently found jointed thread-like filaments, whose precise office is not yet fully ascertained.

Grimmia trichophylla, or the *Hair-pointed Grimmia*, was discovered by Dr. Greville on stone walls near Edinburgh. It has since been found not unfrequent in similar situations throughout Britain; and Dr. Taylor met with it in Ireland; but it does not commonly occur in fruit. It grows in soft, lax, yellowish green patches, with stems of from a quarter of an inch to an inch long, rooting only at the base, and with leaves spreading from an erect base, flexuose, and incurved towards the apex, slightly crisped when dry, and with the margin nearly plane above, but recurved below. The fruit-stalk is yellowish, longer than the perichætial leaves, but curved, as in *G. pulvinata*, while growing; when dry, flexuose and nearly erect. The beautiful little capsule is elliptical or ovate-oblong in form, its walls rather thin, furrowed or angular when dry, and of a pale brown; the lid has a rather long, straight beak. The annulus is large and dehiscent, the calyptra conico-mitriform and lobed at the base, while the teeth of the peristome are densely barred, sometimes entire, sometimes bifid. The laxity of its tufts, and the gradually tapering leaves, sufficiently distinguish it from *G. pulvinata*, even when not in fruit, the leaves of the latter being suddenly and abruptly contracted into hair-points. The inflorescence, too, is dioicous, while in *pulvinata* it is monoicous.

Another Grimmia with curved seta, growing on subalpine rocks in Scotland, Wales, and Cornwall, but of less frequent occurrence, is *Grimmia Shultzii*, *Shultz's Grimmia*. It is a more robust species than the last, has more crowded leaves,

which are subsecund and spreading, with recurved margins, and which gradually taper into long, rough, diaphanous, glossy hair-points, which spread outward when in a dry state. The capsule, too, is thicker and shorter, and attached to a shorter fruit-stalk; but the red teeth of the peristome are longer, more tapering, and more deeply cloven—indeed, so very long and slender are they, that the upper portion not unfrequently breaks off, and remains attached to the fallen lid; the annulus is broader, and whereas the inflorescence of *G. trichophylla* is dioicous, that of *G. Shultzii* is monoicous, the barren gemmiform flower being always found in the vicinity of the perichætium. It fruits in April and May.

Growing on shady or moist alpine rocks in Scotland, Wales, and Ireland, in large green or brownish patches, we have *Grimmia patens*, or the *tall alpine Grimmia*, its stem reaching from two to four inches long, or even more, branched and fastigiate, nude of leaves in the lower part, and decumbent at the base; the leaves are muticous, *i.e.*, destitute of the slender point; they are of firm texture, erect and rigid when dry, rather glossy, the margin recurved below, and carinate, with a stout nerve dorsally two-winged, by which curious peculiarity the species, even in a barren state, may be easily recognized. The perichætial leaves are shorter than the rest, wider below, and somewhat sheathing. The capsule is of a pale brown, smooth at first, but distinctly furrowed when dry, and attached to a rather short, pale, curved fruit-stalk, the annulus large and distinct, teeth of the peristome long and bifid, or bi-trifid at the apex, confluent at the base; lid with rather a long beak, sometimes straight, sometimes oblique, and the calyptra usually five-lobed at the base. Its season of fruiting, like that of *G. Schultzii*, is April and May; but, from the growth of innovations in the stem leaving the fruit in a lateral position, it often escapes observation.

Grimmia Donniana, or *Donn's Grimmia*, grows in small, round, hoary tufts, with branched stems that seldom exceed a quarter of an inch in length. The leaves are narrowly lanceolate, and tapering into roughish diaphanous hair-points scarcely half the length of the entire leaf, which is erecto-patent when growing, erect and slightly flexuose when dry, carinate, of a dark green, with a slightly-thickened border, the very obvious nerve prominent at the back, and continued to the hair-point. The perichætial leaves are longer than the others; the capsule quite erect, oval oblong, of a pale yellowish brown, with thinnish walls, and sub-excerted: in one variety immersed. The lid is short, conical, seldom more than one-third the length of the capsule, more or less obtuse, sometimes slightly apiculate, entire, and without any marginal groove for the annulus, which is persistent. The teeth of the peristome are rather broad,

densely barred, sometimes perforated, but rarely bifid. It is found on rocks and walls in mountainous districts, is abundant near Llyn Ogwen, Carnarvonshire, and elsewhere about Snowdon, and was discovered near Forfar by Mr. George Donn, after whom it is named. It fruits in March, April, and October.

Grimmia ovata, the *oval-fruited Grimmia*, is a larger species, having stems half an inch long or more; more or less compactly tufted, branched and fastigiate, with leaves of firmer texture, more opaque, more erect when dry, and more crowded than in the last species; the margin in the lower part recurved, which it is not in *Donniana*, the nerve broader, but less defined, and less prominent at the back, and the perichætial leaves more erect and sheathing. The capsule is of firmer texture, erect, oval, of a darker hue, being reddish brown, and excerted on a longer pedicel; the annulus is large and dehiscent, and lodged in a groove on the margin of the lid, which is longer and rostellate. It too is found on alpine rocks, particularly on the Breadalbane and Clova mountains. On Snowdon it is rare. Fruiting season, October and March.

Another very distinct species, with dark green foliage, and densely tufted stems of little more than half an inch long, was discovered on trap rocks in King's Park, Edinburgh, by Mr. R. Brown, and to which the name of *Grimmia leucophæa*, or *hoary Grimmia*, has been assigned. While growing, the leaves are widely spreading; but when dry they are closely imbricated, concave, ovate, or elliptical, with plane margins, the upper ones suddenly tapering into very long hair-points, the lower ones muticous. The capsule is elliptical or oblong, of a reddish brown, erect and excerted, perfectly smooth when dry, and with thick walls, the lid variable in length, conico-rostellate, sometimes conical and mammillate, not quite half as long as the capsule, and wearing a calyptra five lobed at the base, and covering one-third of the capsule. The teeth of the peristome are densely barred, the bars externally prominent; they are also deeply bi-trifid and perforated, and are spreading when dry.

G. leucophæa fruits in April. It has been found in various localities—on the coast of Fife; at Fairhead, on basalt; Abbey Craig, near Stirling; and at Salcombe, in Devonshire.

Grimmia unicolor, or the *dingy Grimmia*, grows also on alpine rocks, in broad, incoherent lurid patches, with stems from one to two inches long, more or less branched, the branches flexuose, brittle, and fastigiate, leafless below, but often having slender ramuli, with small ovate imbricated leaves, like those of *G. spiralis*, but more crowded. The leaves of this

species are obtuse pointed, and destitute of the bristle, with a margin so inflexed that the upper part of the leaf might be called semi-cylindrical, and having a broad nerve which reaches to the apex, and so predominating as scarcely to be distinguished from the laminar substance of the leaf. The capsule is ovate, smooth, yellowish-brown, erect, or slightly oblique, and having a lid with a straight or inclined beak half as long as the capsule, annulus large and dehiscent, calyptra dimidiate and rather oblique.

Grimmia atrata, or the *black-tufted Grimmia*, somewhat resembles the last, growing to about the same height, but in more compact tufts, with blackish glossy leaves, rather less rigid than in *unicolor*, less obtuse, with a thinner nerve, though more distinctly defined, and carinate, which the leaves of *unicolor* are not. The fruit-stalk is rather thicker and longer, the capsule longer, and becoming blackish when old; the lid has a shorter beak, and the calyptra is fugacious. The inflorescence in both is dioicous, but *Grimmia atrata* is the more rarely met with. Snowdon and the rocks above Glen Callater have been given as its habitats. It fruits in spring and autumn.

The three other British species of Grimmia have been arranged under the head of *Schistidium*. They differ from those already described in very little more than having immersed and almost sessile capsules, whose columella adheres to, and falls away with their lid.

The term Schistidium is derived from σχίζω, *I split*, or *shiver to pieces*, in allusion to the lacinated base of the calyptra, which is also so small as scarcely to cover the lid.

Schistidium confertum, or the *close-tufted Grimmia*, is densely cæspitose, with ovate lanceolate acuminate leaves, of an intense green colour above, blackish below, the upper ones only shortly hair-pointed, erect and lurid when dry, deeply and acutely channelled above, and with a strong nerve dilated at the back; the capsule oval or roundish, with a shortly rostellate lid, no annulus, and teeth much perforated. It is found on trap or sandstone rocks, and fruits in February and March.

Schistidium apocarpum, or the *sessile Grimmia*, has considerable resemblance to *S. confertum*; the capsule is, however, larger, of darker hue and thicker texture, that of *confertum* being almost pellucid. *S. apocarpum*, too, is taller, more loosely cæspitose; in the larger varieties dichotomously branched, and often procumbent; and the firm, opaque, shortened capsule has a wide mouth in the dry state: the teeth of the peristome are rather long, and of a dark red, those of *confertum* of a pale red or orange colour. The lid is convex, with a short inclined beak, and the calyptra

torn into about five lobes at the base. There are several varieties of this moss with slight but persistent differences. It is found on rocks and walls, sometimes on trees, and fruits in February and November.

The dense dull green or brownish tufts of *Schistidium maritimum*, or the *Sea-side Grimmia*, scarcely average an inch in height, but have longer, narrower, and more rigid leaves, of a glossy and almost horny consistence, and incurved when dry, especially the perichætial leaves, which, though not hair-pointed, have a strong excurrent nerve, of a reddish brown colour. The capsule is soft, of a pale bright hue, obovate-truncate in form, without an annulus, but with large teeth much perforated, and a rostellate lid. It fruits in November and December, and its rigid, strongly-nerved leaves sufficiently distinguish it from the preceding. It is found on rocks near the sea, but, it is said, "seldom, if ever, on such as are calcareous."

Thus we have described the whole family, as at present known and arranged, genus and sub-genus, fifteen in number, and we can promise, from experience, that whoever will take the trouble microscopically to examine their peculiarities, and verify our assertions, will open to themselves a source of intense and abiding interest.

GUNS AND PROJECTILES.

It is probable that through the artillery experiments carried on by the Government, and through the experience afforded by the siege operations of the American war, the attention of the public will once more be strongly drawn to the question of arms and projectiles, and it may therefore be interesting to many readers if we lay before them a few of the chief facts and arguments pertaining to the question, and divested of those technicalities which so often deter students from attempting to understand mechanical problems.

A little investigation will show that fire-arms furnish a variety of conditions under which the laws and effects of motion may be conveniently exhibited, and it is certain that no important improvement can take place in the military and naval apparatus for attack and defence, without great benefit being indirectly conferred upon the arts of peace. We shall not attempt to trace the history of projectiles, but it may be as well at the outset to correct a popular mistake, that the rude fire-arms of our ancestors replaced the bow and arrow simply by reason of their superiority in destructive power. This was

certainly not the case, for while a trained archer was nearly certain to hit a man at 150 or 200 yards, and good shots could accomplish the same feat at double those distances, our soldiers when armed with the old Brown Bess were equally sure of missing any object that a street urchin could not easily hit with a stone. The bow and arrow must, however, have been a most inconvenient arm in actual war. Unless well made and taken care of, the arrows could not be depended upon. The bow was easily damaged and its string much affected by the weather. Moreover, the arrows were a bulky form of ammunition. Sixty cloth-yard shafts would make an awkward load, while the same number of the old fashioned cartridges could be easily carried in a small pouch, and were much more easily kept in good condition. The introduction of the bayonet also gave the musket a great advantage over the bow, for while the latter was worse than useless, except for the discharge of its projectiles, the former, when not wanted as a fire-arm, became a formidable pike.

As a weapon to hit anything with, except by accident, the old musket was one of the worst ever contrived, and the old rifle by which some of its errors were corrected, was not much better beyond a couple of hundred yards. Lest this should seem an exaggeration we will recite a few of the often quoted facts which Sir J. Emerson Tennent brings once more before the public in his interesting popular work entitled the *Story of the Guns.** He reminds us that during the Caffre war, 81,011 cartridges were fired in one engagement in order to make five-and-twenty of the enemy fall; while, during one of the great battles of the French war, a volley fired at thirty paces only brought down three men out of a squadron of cavalry charging a square. Trials made in 1838 showed that a target three feet wide, and nearly twelve feet high, was missed by one quarter of the balls at 150 yards, and at 250 yards not a single ball out of ten hit it when its width was increased to six feet.

The conditions necessary for missing the object shot at, were thus admirably fulfilled, and we may learn something by ascertaining what they were. In the first place the projectile was a round ball, fitting the barrel loosely and jammed in with a paper cartridge. After the explosion of the powder it would bump up and down, or from right to left in the barrel, and rotate besides. When it left the muzzle no one could guess whether the deviation from the true course would take it too high or too low, too much on one side or too much on the other. In addition to this unknown and unknowable amount

* *The Story of the Guns*, by Sir J. Emerson Tennent, K.C.S., LL.D., F.R.S., etc. *Longmans.*

of initial error, it would suffer further equally unknown and unknowable deflections as it went along. Its centre of gravity might not have been co-incident with the centre of its sphere; and if it were so when it entered the barrel, the shape was sure to suffer from the explosion, so as to throw it out. There were also more refined reasons why a round ball could not be depended upon to move in one plane during any considerable flight.

In the early rifles the ball was driven into the barrel so as to fit tight, and one source of error was thus removed. Moreover, it was found that the grooving of the rifles could be made to spin the ball about an axis parallel to the sides of the barrel and coinciding with the plane of its intended flight. Under these circumstances, and by avoiding crushing the ball out of shape in the process of loading, very fair shooting could be accomplished at from fifty to a hundred yards, and moderately bad shooting at twice that distance. During the continental war it was a great achievement if anybody was made unsafe by rifles at four hundred yards, and the artillery was proportionably ineffective as a destructive weapon.

Among the earliest people to introduce greater precision into their arms were the Americans and the Swiss, both of whom adopted principles pointed out by Robins, the mathematician, and even by Newton. Without giving them exclusive credit, they practically demonstrated that projectiles must not be round, if the best effect was to be obtained. A round ball is easily started with a high velocity, but the surface of resistance it opposes to the air is so great in proportion to its moving power* that it soon takes to a slow trot, and then comes to rest. If three or four balls be placed one behind the other, it will be seen that so long as they touched each other, and moved straight forward, the front one would clear the way, and the others would pass with comparatively little opposition. This is, in popular language, the philosophy of elongated projectiles; but to enable them to act well they must always move in one plane. As long as they go face foremost, they have, as compared with a round ball, the advantage (supposing the velocity to be the same) of the additional momentum due to their greater weight, while their area of resistance is not proportionably increased.

The mechanical problem which the improvers of the rifle had to solve, was to obtain the best form of elongated projectile, and prevent its turning over or going side foremost in its flight. It was soon found that a long conical projectile could be made to move with its smallest and lightest end foremost for many

* The momentum of a projectile is equal to its weight multiplied by its velocity.

hundreds of yards, provided it was made to revolve with sufficient velocity about its long axis all the time. So successful were the Swiss in applying these principles, that, as Mr. Wilkinson showed in an able pamphlet published in 1822, they could put twenty bullets in succession into a target ten inches square, and 200 yards off, and at 800 paces they put forty bullets into a target fifty-five inches square. At 1000 paces, on a calm day, 100 bullets in succession struck a target eight feet six inches square.*

Our Government, from its unfortunate antagonism to science, was, of course, one of the latest in the field, and then, after an expensive blunder with the so-called "Minie pattern," it adopted the Enfield, an immense advance on the former rifle, but constructed in defiance of the principles thoroughly established by scientific experimenters. The faults of the Enfield rifle were, and are, its feeble power of spinning a long projectile, and the consequent necessity for using one of a clumsy shape that moves like a cart-horse, and in a course needlessly elevated above the ground.

Mr. Whitworth—that great master of accuracy in things mechanical—soon after turning his attention to the subject, produced the most perfect rifle yet seen. As might have been expected from his extraordinary talent in devising the best mode of ensuring a close approximation to mathematical truth in workmanship, he is able to produce uniformity of excellence to a wonderful extent. As stated in Sir Emerson Tennent's work, the principle of Mr. Whitworth's success "was found to consist in an improved system of rifling, a turn in the spiral four times greater than the Enfield rifle; a bore, in diameter, one-fifth less; an elongated projectile of a mechanical fit; and last, but not least, a more refined process of manufacture." In the Enfield rifle "the spiral course to be traversed by the bullet makes one turn round the interior of the barrel in advancing six and a half feet; but this moderate degree admits only of the use of short projectiles, as long ones turn over on issuing from the muzzle, and short ones become unsteady at great ranges. Mr. Whitworth adopted with his reduced bore one turn in twenty inches, which he found ample for securing a comparatively steady flight over a range of 2000 yards."

Mr. Whitworth's rifling is commonly described as hexagonal; but, as Sir Emerson Tennent says, this is scarcely correct. "He converts the entire inner surface of the barrel into something approaching a hexagon, leaving in the middle of each division of the plane surface a small curved portion coincident

* Many writers confound the Swiss *military* rifle with that employed in village target shooting, which is not constructed for long range.

with the original circular bore of the gun, and rounding the angles to contribute to the strength of the barrel." His projectile is made to correspond by its polygonal and sloping surfaces with the rifling of the barrel.

Having been more attentive to scientific considerations than the contrivers of the "Enfield," Mr. Whitworth naturally obtained far greater success, and we cannot describe this better than in the words of Sir Emerson Tennent, who observes:

"The Whitworth rifle was first formally tried in competition with the best Enfield musket at Hythe, in April, 1857. . . . . The success was surprising; in range and precision it exceeded the Government musket three to one. Up to that time the best figure of merit obtained by any rifle at home or abroad was 27: that is to say, the best shooting had given an average of shots within a circle of 27 inches mean radius at 500 yards distance; but the Whitworth lodged an average of shots within a mean radius of four and a half inches from the same distance; thus obtaining a figure of merit of 4½. At 800 yards its superiority was 1 to 4, a proportion which it maintained at 1000 yards and upwards. At 1400 yards the Enfield shot so wildly that the record ceased to be kept; and at 1800 yards the trial ceased altogether, whilst the Whitworth continued to exhibit its accuracy as before."

It would not be just to the memory of the late General Jacob to omit the fact that, by employing a well-shaped projectile and a high twist in his rifle, he had achieved a success almost as remarkable as that of Mr. Whitworth. In 1855 he recommended a rifle with a twenty-four gauge bore, having four grooves, and carrying a projectile of a curved conical form, resting on a short cylindrical base, and he states that with it "a tolerably good shot can certainly strike an object the size of a man once out of three times at 1000 yards distance, and the full effective range is near 2000 yards—the ball at that range flying with deadly velocity."*

An important question connected with a high twist of the rifled barrel is, what influence is exerted on the force of the projectile and its range by the rapid rotation which it induces? If it lessened the rapidity of its flight, so as to diminish its destructive powers, it would be open to grave objections. It is necessary in replying to this inquiry to pay attention to the circumstances under which the rapid rotation is produced. If the friction of the projectile against the sides of the barrel is greatly augmented, a considerable loss of force and range must be the result; but by adopting different systems of rifling and different projectiles, it is easy to communicate a similar amount of spin or rotation with widely different proportions of

* *Rifle Practice*, by Major John Jacob, C.B. *Smith, Elder, & Co.*

loss from this source. The practical question therefore is, how to communicate a high velocity of rotation with the smallest amount of friction, and up to the present time this problem has been most successfully solved by Mr. Whitworth. In an experimental barrel, twenty inches long, Mr. Whitworth made twenty turns, so that when the projectile was fired from it, the rotation velocity was much greater than the velocity of the forward movement, and yet it penetrated seven inches of elm. In a paper quoted by Sir Emerson Tennent, Mr. Whitworth says, that "in some projectiles I employ, the rotations are 60,000 a minute. In the rotation of machinery 8000 revolutions a minute is extremely high, and considering the *vis viva* imparted to a projectile as represented by a velocity of rotation of 60,000 revolutions, and the velocity of progress 60,000 feet per minute, the mind will be prepared to understand how the resistance of thick armour plates of iron is overcome, when such enormous velocities are brought to a sudden standstill." The smallest amount of friction will take place between smooth, nicely adapted, perfectly clean and well lubricated surfaces, fitting tight enough to prevent the escape of the gasses that impel the projectile, but not jammed against each other with needless force. The inside of a good rifle should therefore have a shape that is easily kept clean, and in this respect Mr. Whitworth's modified hexagon, and Mr. Lancaster's oval, possess an advantage over all intricate groovings.

A cannon is merely an enlarged shoulder gun, to be fired from a mechanical stand, instead of from the human body, It however presents peculiar difficulties in its requirements. In the first place, its size is an obstacle to perfect workmanship. It is comparatively easy to forge a rifle barrel weighing from five to eight pounds, without any flaws or defects; but the same process cannot be repeated with the same certainty with a barrel weighing several hundred-weights, or tons. The cast iron ordnance was an attempt to make quantity of material a substitute for quality, which had to be abandoned when greater perfection of performance was required. Then homogeneous iron carefully forged, together with various modes of strengthening the barrel by additional layers of metal, either welded on, or simply forced on in close contact, had to be resorted to. An interesting work might be written on this part of the question, and on the various modes that have been adopted with greater or less success; but we must not pursue the subject now, or we should be led too far away from other considerations. Let us pass to a second peculiarity in cannons as compared with muskets—the necessity for firing hard iron projectiles, instead of soft lead, that readily accommodates itself to rifle grooves. If a cylinder of lead or any other soft metal is

dropped into a barrel which it loosely fits, the moment the powder is ignited it "hammers up." That is to say, its nether extremity receives such a rapid thump that the mass has no time to evade its force by getting out of the way, and consequently the projectile is instantly made thicker and shorter. An iron cylinder would, with an ordinary charge of powder, be so slightly acted upon in this manner, that it would not be driven into the grooves, and if it were so driven, the friction would be tremendous in the subsequent attempt to force it through the barrel. Mr. Lancaster proposed elliptical iron shot, and barrels of an elliptical form, with the major axis twisting in a spiral as it descended. This plan achieved considerable success with rifles and leaden projectiles; but failed when applied to cannon. General Jacob proposed four-grooved cannon, and four projections or wings from the balls. Sir William Armstrong, with great skill, constructed cannon to fire compound projectiles—iron for strength and penetration, and lead to take the rifling, as in small arms.

It is impossible to look at an Armstrong gun without great admiration for the beauty of its manufacture; and its performance is astounding for accuracy if compared with most other patterns. Independent, however, of the defects of its method of breech-loading, it seemed marked out from the beginning as a provisional weapon only. Projectiles composed of two metals could only be regarded as substitutes for the best mode of making and discharging projectiles made entirely of iron or steel. The grooving of the Armstrong gun, although very beautiful, was a recurrence to a plan not found to be the best in small arms. A multiplicity of small sharp grooves with a moderate twist marked the weapon as likely to lose much power by needless friction, and not to be able to attain a maximum of velocity or range. So successful has Mr. Whitworth been in this matter that, as Sir Emerson Tennent states, "The average initial velocity of a sixty-eight pound spherical shot thrown from a smooth bore, with a charge of one quarter its weight of powder, is 1600 feet in a second, and this it very speedily loses. On the other hand, with a shot of the same spherical form, but rifled to fit the gun, Mr. Whitworth's obtains an initial velocity of 2200 feet in a second." This increase of velocity is obtained by the accurate fit of the projectile, and consequent prevention of the escape and waste of the gases into which gunpowder is resolved. In the Armstrong pattern the gain would be less, because the friction is so much more. Sir William estimates the force required to squeeze his twelve-pound shot into the grooves of his cannon at *several tons*, "whereas in the Whitworth gun, the shot being already rifled and fitted to the bore, it may be started and drawn through the barrel with a silken thread."

The advantage of great velocity and capacity for extreme range, is not confined to distant shots, as it is a most important element in facility of hitting any object whose distance is not exactly known. Suppose it possible for a projectile to move in a *straight line* from the muzzle of the gun to the object shot at, no change of elevation would then be required for different distances. Now the nearer you can approximate the path, or trajectory, of a projectile to a straight line, the less it matters whether you guess the distance a little more or less. If the projectile goes high up in the air above the object, and then rapidly tumbles down to it in a descending curve, accurate shooting may be managed at targets whose exact distance is known; but an error of a few yards in guessing the distance and arranging the elevation would cause an object that was not very tall to be entirely missed. Again, in firing at an advancing body of men, the ball that goes up in the skies and then plumps down, is very unlikely to hit more than one if the best aim be taken, while the comparatively straight-going ball may knock down a dozen, one behind the other.

We must now consider another point—the power of projectiles to penetrate iron plates or other shock-resisting medium. This needs, first, great velocity; secondly, sufficient weight and strength in the projectile; thirdly, such a shape as will enable the projectile to break through the resistance, and not be broken itself. Pointed shots fail against great resistance, because, at the moment of striking, their pointed ends, being unsupported, give way. Flat-headed cylinders appear to answer best, and, if proceeding quick enough, easily punch their way through targets like the sides of our "Warriors," which were supposed, until tried, capable of resisting any force. An interesting epitome of various experiments with the Whitworth and Armstrong guns is given by Sir Emerson Tennent, but we shall not dwell upon these incidents: first, because they are pretty well known; and secondly, because further experiments may throw them into the shade.

We will, however, recall two experiments, in one of which a solid hexagon shot weighing 129 pounds was fired from a Whitworth gun at 600 yards. It struck the target within an inch of a white spot at which it was aimed, and pierced 4½ inches of iron, and shattered, though it did not pass through, 18 inches of teak lined with iron ⅝ths of an inch thick, and supported by upright angle irons, that arrested its course. Mr. Whitworth afterwards fired a shell through the same target. When the projectile struck the target a bright sheet of flame was occasioned by the sudden arrest of such an amount of motion.

When rifle ordnance was first seriously discussed, it was

predicted that they would not do for shells; but Sir William Armstrong proved that, on the contrary, they would fire a more destructive kind than had been previously employed, while Mr. Whitworth demonstrated that if made of the right pattern, they could be easily driven through any of the iron ships in the navies of England or France.

When projectiles are fired from guns, their velocity diminishes as they proceed, and no attempt has as yet been successful to give the requisite accuracy to rockets, which supply their own motive power as they go along. Sir William Congreve did much, and Mr. Hall improved upon his plans; but no rocket has yet approximated to the accuracy of a shot receiving its impulsion from a charge of powder in a gun. An ordinary projectile suffers no change in the position of its centre of gravity during its course; but a rocket carries a composition that goes on burning, and thus it may be said to be continually discharging ballast, and shifting its weight. Whether this will ever be compensated, and whether it will also be found possible to regulate the direction and force of the gases discharged from its tail, we do not venture to say; but if some future Whitworth could perfectionate a rocket fired from a rifled gun, it would probably penetrate anything that could be made to float.

The size of ordnance is almost as important as their construction, and perhaps a rule might be laid down to use the biggest that all the circumstances conveniently permitted. There are cases in which small guns fired often, would be more advantageous than big ones fired at greater intervals; and it is certain that monsters could not be fired as often and as quickly as those of moderate size. In other cases, as in attacking ships or forts, size must be an important element of success—a single shell of great bulk being able to destroy any vessel it could penetrate, or blow up an immense quantity of earth or stone work. Should our engineers succeed in constructing really serviceable guns, capable of throwing 1000-pound shot or shell, ships might become simply floating stocks for one or more of such barrels, and in any case it may be doubted whether leviathan vessels that offer so much to shoot at, and are so difficult to manage, will maintain their ground.

We shall, in conclusion, say a few words on explosive substances, and their action. In dealing with a projectile you wish to communicate to it, *as a whole*, as much motion as you can. When your powder is exploded, a solid is suddenly converted into gases, which, in a highly heated state, are supposed to occupy more than 2000 times the original bulk. The velocity of the transition from the solid to the gaseous state is also enormous, though far less than in certain other compositions of

an analogous nature. Now it is possible to strike the base of the projectile and the sides of the gun with such force and velocity as to break up their cohesion; but this is destroying the carriage and the passenger instead of conveying him quickly to his legitimate destination. When we sit in a railway train and the engine starts, we feel a jerk as the coupling chains are extended, and the vehicles are pulled. If this jerk were greater than the chains would bear, they would be broken, and perhaps the carriage also, but we should scarcely move. If the engine, as it sometimes is the case, were placed behind, and it shoved the carriages too rapidly, they would be smashed without receiving much forward motion. This will explain why, with gunpowder, or its substitutes, too great a velocity of action will not answer. The chemical composition, the size of the grains, the mode of ignition, all influence the rate at which solid gunpowder is changed into heated gas. When it is intended to burn a given quantity of powder in order to communicate velocity to a projectile of particular weight, the preceding circumstances have to be considered, and also the best mode of packing the powder, whether it shall occupy a broader or a shorter column. The length of the barrel must also be proportioned to the quantity of powder and the rate at which it burns.

Hitherto, gunpowder has not been surpassed for practical utility in fire-arms, but recent Austrian experiments again revive the claims of gun-cotton, and perhaps other compounds, as yet unknown, may prove more convenient than either. Looking at this, and to other probabilities, we must not expect that we are to solve for ever the problem of the best gun and the best projectile. All that we can reasonably desire is, that, whether the skill of our nation is permitted to develope itself in peace, or unfortunately compelled to exercise itself in war, we may be amongst the foremost in science, and amongst the most ready to welcome useful novelties and cast old prejudies and ignorances aside.

AEROLITES WITH LOW VELOCITIES.

The following is a translation of the principal passages of a letter by M. L. Sœmann, in *Comptes Rendus*, 4th January, 1864:—

"I have the honour to present to the Academy the largest fragment that was picked up of two aerolites which fell on the 7th December last at Tourinnes-la-Grosse, nine leagues south of Louvain in Belgium. The desire to obtain good specimens for the scientific collections of Paris, caused me to visit the spot immediately after the event. The periodical *Les Mondes* published in its number for the 20th December, statements collected from ocular witnesses of the fall, and which differ little from similar relations. The largest stone was seen to shatter itself on the pavement of the village. Fragments were collected and carried off by different persons, but the greater part was reduced to dust and lost. The second stone was found two days afterwards in a fir-wood about two kilomètres from the village. It is from this aerolite I obtained the two large pieces which I place before the Academy; the remainder, which was twice as big, seems to have been destroyed by persons who wished to see its inside. Both stones are exactly alike, except that some spots of rust soil the fragments of the first, which were exposed to the dampness of the earth before they were picked up. The clean stone is whitish-grey, of a fine close texture. Its density is 3·52, and disseminated through it are very small metallic grains, some of a fine silver-white, attracted by the magnet, and others, more numerous, of a bronze colour, not magnetic, but soluble in hydrochloric acid, with disengagement of sulphuretted hydrogen—characters indicating metallic iron and sulphuret of iron. The stony matter was slightly fusible, and readily attacked by hydrochloric acid. Scattered through it were rare globules of a brown substance easily isolated by soaking the stone in concentrated hydrochloric acid. When separated, these globules fuse with great difficulty into a black enamel, while the acid exhibits the green tint characteristic of nickel."

Mr. Sœmann then states that the facts relating to these Belgian aerolites suggest observations analogous to those he made with reference to the fall which took place at Ormes in October, 1857. Aerolites have been supposed to arrive with planetary velocity within the earth's sphere of attraction, and he refers to the efforts that have been made to compute the heating effect of an arrestation of their motion by the resistance of our atmosphere, and states that Bunsen and Bronn in the *Neues Jahrbuch der Mineralogie*, 1857, *p.* 265, calculate that the com-

plete arrestation of a mass of iron having such a propulsive force would raise its temperature a million degrees, of which the greater part would be lost by radiation and contact with the air. "It is supposed," he adds, "that a black crust invariably found in aerolites is the effect of fusion resulting from the friction of the air. The strong detonations have been attributed to the explosion of the aerolites in consequence of the great tension resulting from the coldness of their interior, and the heat of their exterior portions." If these theories were accepted, he points out that, it would be necessary to assign to all aerolites having a black glazed surface and experiencing detonation, a velocity sufficient to fuse their external parts. In the case of the aerolites of Tourinnes he affirms that the velocity was very moderate—certainly less than that of cannon-shot. In proof of this he remarks, that when a body advances with great velocity its form cannot be seen, while at Tourinnes those who saw the aerolite agree that it looked like an elongated cylinder.

The second proof of small velocity he derives from the fact that persons who heard the explosions had time to get out of their houses and look at the aerolite before it fell. Thus it could not have advanced as quickly as the sound travelled. In the case of the aerolite of Ormes, a mason assured him that the fragments of the stone bumped from branch to branch of the tree on which they fell. At Tourinnes "the second stone, supposed to have weighed six or seven kilogrammes, struck a young fir about eight centimètres in diameter; and although its trunk was completely flattened by the force of the blow, it was neither cut through nor penetrated by the great projectile, the force of which appears to have been completely deadened, as the stone was found half buried in sandy soil less than a mètre to the right of the tree."

The heat of a portion of one of these aerolites, picked up immediately after its fall, was estimated at 50° Cent.

It will be interesting to see what comments astronomers and physicists will make upon these curious observations.

THE WIND AND ITS DIRECTION.

BY E. J. LOWE, F.R.A.S., F.L.S., ETC.

THE registration of the changes of the wind as marked down by the "Atmospheric Recorder," is known to but few persons. Only one instrument is at work, and this is at the Beeston Observatory. The value of the instrument is so great that it deserves to be described.

The late Mr. Henry Lawson, F.R.S., of Bath, and the late Mr. George Dollond, were the inventors and constructors of this machine.

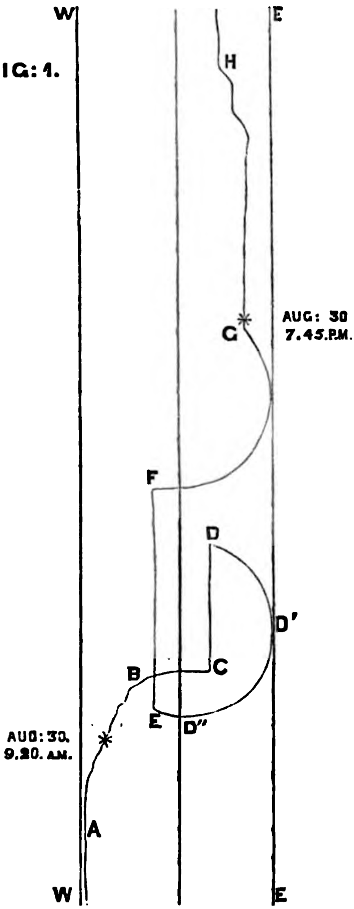
Sir John Herschel had published a request to all observers to make constant observations for twenty-four hours on four specified days in each year; and Mr. Lawson being an ingenious mechanic and an active observer of the weather, considered that he was bound as a philosopher to assist; he therefore determined to have a machine constructed that should record by mechanical contrivances all the changes that take place in the atmosphere at the time of the occurrence. After expending many hundred pounds, he at last succeeded in producing an instrument that would do the following work with a number of pencils and zero pencils :—

Pencil 1 records the hour on the west edge of the paper.
„ 2 is the zero pencil for rain.
„ 3 records the commencement and termination of every shower, and the amount of rain fallen every minute.
„ 4 is the zero pencil for evaporation.
„ 5 records the amount of evaporation every minute.
„ 6 is the zero pencil for temperature (marking the freezing point).
„ 7 records the temperature of the air every fifteen minutes.
„ 8 is a zero pencil for wind direction, drawing the zero of a west wind.
„ 9 is a zero pencil for wind direction, drawing a north or south wind according as the curve is convex or concave on this line.
„ 10 is a zero pencil for wind direction, drawing the zero of an east wind.
„ 11 records the wind's direction every minute.
„ 12 is the zero pencil for the force of the wind.
„ 13 records the force of the wind in oz. and lb. pressure on the square foot every minute.
„ 14 } are the zero pencils of the hygrometer, the one drawing the line of *perfect dryness*, the other that of perfect
„ 15 } saturation.

Pencil 16 records the hygrometrical state of the air every fifteen minutes.
,, 17 records the amount of atmospheric electricity.
,, 18 } zero pencils from the barometer, the one marking a zero of 28 inches pressure, and the other one of 31 inches.
,, 19 }
,, 20 records the height of the barometer every fifteen minutes.
,, 21 records the hour on the east edge of the paper.

It will thus be seen that twenty-one pencils are constantly employed, and, in fact, doing the work of a whole corps of observers. Our present purpose is not to describe the instrument except as regards the wind-pencils.

FIG: 1.



It is of the greatest importance to have the means of knowing when every change in the wind takes place; and were a dozen instruments like the "Atmospheric Recorder" in action, in as many well-selected places in England, we should speedily know more about the wind and its movements. Waves of air would be detected, and the time when they passed across each observatory accurately recorded.

From this instrument we learn that the wind works in several different ways, at one time *a steady immoveable current* in a certain direction, which can change to any other direction without oscillation; at another, it is *nodding* on a certain point of the compass; whilst, at a third, it *oscillates*, and sometimes violently, so that (as instance) a south wind may be immoveable in south, or it may slightly move 1° or 2° on either side of south, or it may oscillate from S.W. to S.E., or even from W. to E., and still be a south wind.

To understand this correctly we will take several examples, but before doing so, it is requisite to mention that a long piece of drawing paper is placed upon a roller; this passes between two brass cylinders on to a glass table, at the end of which is another roller with weights, a clock drives this paper across the table at the rate of half an inch an hour, and the roller and weights wrap it up after the records have been made. Fig. 1 is an exact copy of the movements of the wind on the 30th of last August, the two stars showing the direction at 9·20 a.m. and 7·45 p.m. The line WW is the zero of a west wind, the line EE that of an east wind, and the line NN that of a north wind, if the curve is *concave*, but south if *convex*. It will be sufficient to say, that if the wind pencil (which writes amongst these three lines) touches the line E, it must be east and so on. The wind on August 30th, 1863, is an example of a stationary wind, although the changes between 10 a.m and 8 p.m. were most extraordinary. The wind had been blowing WNW. where marked A, on reaching the star (*) NW., at B it was NNW., moving in one sweep from B to C, at C it was NNE., in which quarter it remained till the point D was reached, it then veered in one sweep through east (D′) and south (D″) to nearly SSW. (E), remaining in this quarter to F, then sweeping through E. to NE. (G) at 7.40 p.m., remaining for some time in this quarter, and becoming NNE. at H, so that from A to G in the space of twelve hours the wind moved—

WNW. to NNE.	=	90°
NNE. to SSW.	=	180°
SSW. to E.	=	112½°
E. to NE.	=	45°
		427½°

Or 427·5° without a single oscillation.

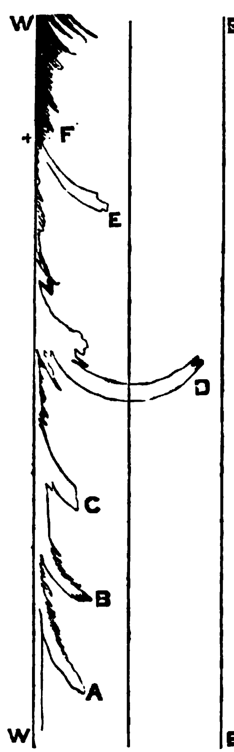


FIG: 2.

JAN: 25.
10.A.M.W.

In Fig. 2 we have a different character of wind (the example being on January 25th, 1864), what I have called a *nodding wind*, on WSW., with veerings to SW. at A, B, and C, and a singular change through S. to ESE. at D, and back again in

half an hour, another change at 10 a.m. to SSW., and back again, after which the wind oscillated gently on WSW.

In Fig. 3 (January 23rd, 1864) we have an example of an oscillating wind, which was violent at first on S. (the oscillations reaching from SW. to ESE.), then SSW. (the oscillations extending from W to SSE); at 5·20 a.m. suddenly veering to WNW. (with small oscillations) and then to WSW. In this diagram a gale of wind occurred, and the manner of registration is shown in Fig. 3, the line *O O* being the zero pencil line of a calm, and A, B, C the registration of the wind's force on the square foot, the greatest violence of the gale occurring at B, when 7lb. was registered.

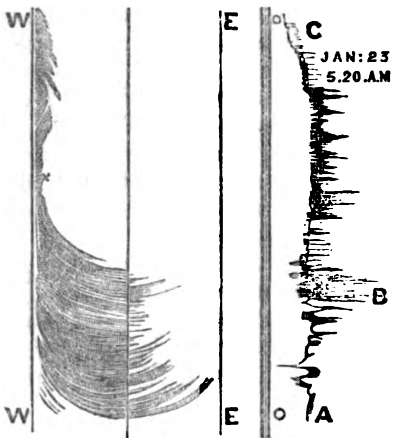


FIG: 3.

The value of such a series of registration is great, and especially so since Mr. James Glaisher has shown that a wind law exists, a law of movement in which in some years the direct movements exceed the retrograde; whilst in other years the retrograde movements predominate, *i.e.* when *direct*, working forward like the hands of a watch, and when *retrograde*, moving in the opposite direction.

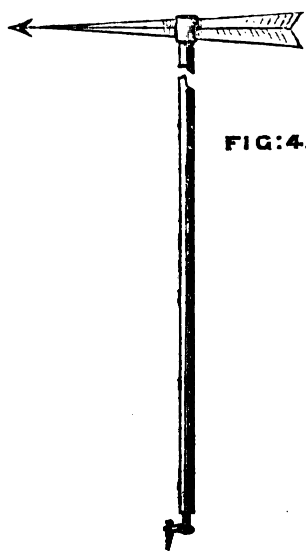


FIG: 4.

The contrivance is so simple that it cannot get out of order, consisting of a simple brass rod, to the upper end of which a wind vane is attached, whilst at the base a pencil on a short arm records all the movements as the rod itself turns round, Fig. 4. This brass rod is taken advantage of for the wind's force; being hollow, a wooden rod extends through it, attached to a force board on the vane; whilst immediately above the registration table a cradle is suspended,

to which is attached a conical cup containing different lead weights, ranging from half an ounce to 36 pounds. According to the force of the wind these weights are raised, and the pencil marks the exact weight lifted up.

The "Atmospheric Recorder" and many other meteorological instruments were presented to me *by Mr. Henry Lawson*, and are now doing me good service at the Beeston Observatory.

CONSTANCY OF SOLAR LIGHT AND HEAT.

BY ALEXANDER S. HERSCHEL, B.A.

THOSE who admit no waste of power in the different operations of the energies of nature must encounter the difficult question of the maintenance of a constant source of light and heat upon the surface of the sun. The sun constantly delivers to the earth, in heat alone, an energy equal to the hundredth part of that force by which it constantly draws the earth into a spiral path about itself. This is but the two thousand millionth part of the total heat, or energy, which the sun continually develops and dismisses into space; yet the efflux is unabated, and has apparently remained the same from the earliest historic ages, and from the remotest ages of geology, to the present time.

Misled by the almost fabulous scale of this outlay, some have attempted to persuade themselves that a new theory of solar radiation might prove the estimate to be overdrawn. They propose to consider that solar heat, like gravity, is imparted only to surrounding objects, by a species of reciprocation, or by a sympathetic interchange between the sun and other bodies; and that it is the part of surrounding bodies to disperse the solar heat into space under the usual laws of radiation and in the ordinary form of radiant heat: did they not do so, that these bodies and the sun would reach an equilibrium of temperature by an interchange of heat, and would maintain it unabated to the end of time.

This theory, in itself incredible, makes it yet apparent that if a reasonable explanation could be given of the constancy of solar light and heat it would be accepted, by analogy, as a step towards the better understanding of the great law of Newton—that one particle constantly attracts another in proportion to its mass.

The sun as a merely heated body would fall in temperature and lose its light sensibly in the course of a small number of years, or even months. This temperature does not appear greatly to exceed that of the electric arc, but it remains un-

changed. At such a temperature many, perhaps all, chemical compounds are dissociated into their elementary parts. Were all the elements of the sun dissociated by reason of an uniform prevailing temperature, their gradual recombustion, and exertion of their chemical affinities, would maintain the constant temperature of the sun for a prolonged period of 8000 years. Neither Original heat alone, nor Original heat combined with chemical attraction, are, therefore, sufficient to continue the solar activity for an indefinite time. These two operations may be seen in action together in a fireball with a permanent streak of light. The fragments of the meteor are red in light, and rapidly disappear as their temperature falls and vanishes by radiation. The streak is of immensely higher temperature, and the recombustion of its dissociated vapours maintains the high temperature at a constant value for many seconds, and occasionally for many minutes after the disappearance of the fragments. A continual repetition of meteors would be required to supply the earth with incessant light from such a source, and such a succession of meteors is therefore supposed to occur upon the surface of the sun. It is calculated that a yearly deposit sixty-six feet in depth of solar satellites would actually suffice to maintain the present supply of solar light and heat unchanged: a quantity much too minute to be perceived in less than many thousand years by angular measurements of the sun's diameter.

The light and heat of meteors upon the earth are confined to the highest strata of the atmosphere. It appears that this is equally the case upon the sun, and that the meteoric particles from their minuteness are consumed, and all their elements dissociated at the boundary of the solar atmosphere. Their fiery streaks alone remain. Like steam condensing into water, these maintain their high temperature until all the elements have re-combined and dispersed abroad their latent heat. Such streaks are actually seen upon the sun as straw-like or leaf-like lines, which intersect each other in every conceivable direction. When cooled, the matter must descend as dust or in drop-like pieces upon the surface of the sun. The spots which appear upon the luminous envelope of the sun may arise whenever an aerolitic mass of large dimensions penetrates to the solar surface unconsumed, and with volcanic violence destroys the order of the atmospheric strata where it strikes. The spots are far removed from the solar poles, and therefore near the plane of the ecliptic where the planets have their orbits; but the leaf-like lines are seen over every portion of the sphere of the sun, like fireballs at the surface of the earth. Chemical affinity may thus be said to act the part of a damper and regulator of the solar fires, reserving portions of the heat suddenly imparted to the sun, and again maintaining its uniformity of tempera-

ture, when a cessation of the impulses would otherwise be followed by a waning of its light.

If no illustration can be found in the regular emission of solar light and heat, to the constant exercise of gravitation in every particle of matter, at least it appears more philosophical to approach the unexplored ground by open paths, than to ascribe both these principles of solar heat and gravitation, together, to mysterious agency, on account of their activity alone.

INSANITY AND CRIME.

THE attention of the public has been very strongly called by a recent case to the question of insanity and crime, and it may therefore be a convenient opportunity for endeavouring to ascertain a few of the scientific principles by which such investigations should be guided, and jurisprudence controlled. In the first place let us endeavour to limit the inquiry within the bounds of the *knowable*, for it is clearly useless, or even mischievous, to suffer ourselves to be led astray in the performance of practical duties by indulging in speculations which the restricted nature of our faculties must of necessity render uncertain, and incomplete. When any member of our society has committed an offence, we must not expect to be able to measure the actual quantity of his guilt. To do this we should have to ascertain the precise force of the temptation that led him astray, and the precise force of the resistance to the temptation which he might have exhibited had he strongly desired and earnestly willed to do that which was right. Not only should we have to ascertain these facts in relation to the actual state of the individual at the period of the commission of his offence, but we ought to have the whole of his life-history before us, in order that we might discover at what times he had destroyed the just balance of his faculties, by performing acts or acquiring habits that were bad, when it was within his power to have performed and acquired acts and habits that were good. It is quite plain that such an inquiry would far transcend all human powers, and we must therefore confine our researches to a humbler sphere, and go to the work with a consciousness that our most careful judgments are likely to be wrong.

Practically, our proceedings must be limited to two inquiries: firstly, whether an accused person did really commit the act which our law declares to be an offence; secondly, whether he was labouring under *physical* conditions that detracted wholly, *or to a great extent*, from that normal position of responsibility which we feel justified in assigning to human

beings. No one has ever pretended that all men are responsible in equal degree for their actions. The divine, the moralist, and the popular voice, all exclaim, concerning one offender, that his offence is aggravated by his position and circumstances; while they say of another, that his error admitted of much excuse. Morally, the duty of each is to make the best use he can of the faculties assigned to him, and unless we could prove that all men were born with equally good organizations and lived under equally beneficial conditions, we could not establish the theory that all were equally worthy of praise when they did right, or equally deserving of blame when they did wrong. But while we are compelled to recognize responsibility as existing in different degrees amongst persons whom we have no right to consider insane, and also among those to whom that epithet may be applied, our jurisprudence can only take cognizance of differences that are obvious and clear. There is a sense in which all sane criminals may be considered insane, for serious crime is seldom committed until habits have been formed, by which animal propensities have been encouraged to gain the upper hand. Such cases are, however, widely distinguished from actual cerebral disease, and it is the determination of the existence or nonexistence of disease that imposes upon our tribunals one of their hardest tasks. If an accused person has the obviously defective brain of an idiot, and his mental manifestations have always corresponded with the idiotic type, no difficulty is felt. The trouble begins when an individual has been deemed sane up to commission of a crime, and we have to take the crime itself, with all its attendant circumstances, as part of the evidence by which insanity may be demonstrated.

The ideas of insanity enshrined in the decisions and *dicta* of our most eminent judges are so obviously absurd that it is astonishing they could ever have been tolerated in any society pretending to civilization. In Bellingham's case, Lord Mansfield told the jury, that before the prisoner could be acquitted on the plea of insanity, "it must be proved beyond all doubt that he did not consider murder was a crime against the laws of God and nature;" and in McNaughten's case, when the House of Lords propounded certain questions to the judges, Mr. Justice Maule replied, "that to render a person irresponsible for crime on account of unsoundness of mind, the unsoundness of mind should, according to the law, as it has long been understood and held, be such as to render him incapable of knowing right from wrong." Chief Justice Tindal brought *legal insanity* to a climax by informing their lordships that "we" (the judges) "are of opinion, that notwithstanding the party accused did the act complained of, with a view, under the influ-

ence of insane delusion, of redressing or avenging some supposed grievance, or injury, or of producing some public benefit, he is nevertheless punishable, according to the nature of the crime committed, if he knew at the time of committing such crime he was acting contrary to law!"*

Thus the English law decides the question of responsibility upon singularly unscientific grounds. Its test is totally fallacious, and it errs moreover, by a false assumption, upon which Dr. Bucknill thus comments:—"It is the system of the English law to allow no degrees of responsibility. A criminal is either responsible or he is irresponsible: there are but two classes, in one of which room must be made for every one who commits an offence. In nature we find no such sharply defined classification."† So far indeed from absolute irresponsibility being a result of insanity, it is scarcely, if ever, the case; and Langerman, cited by Dr. Bucknill, observes, "that even in the highest degree of insanity there still remains a trace of moral discrimination, with which we may connect the train of the patient's ideas."

In modern lunatic asylums a prominent part of the remedial treatment consists in making the patients feel that they ought, and can, comply with the wholesome regulations arranged for their benefit. The directors of such establishments lessen their inducements to act foolishly by removing incentives thereto, and they strengthen their resisting power by calling appropriate faculties into play. Long ago Haslam cited with approbation the following passage from Dr. Cox, who said:—"The maniacal patient, however torpid, must be roused; or, on the contrary, when an opposite state obtains, extreme sensibility and impatience of powerful impressions, there may be much expected from placing the patient in an airy room, surrounded with flowers breathing odours, the walls and furniture coloured green, and the air agitated by the softest harmony."‡ The use of such attendant circumstances was to bring the patient's organism to a more balanced state. Without the rousing or the soothing influences, the disease controlled him; under them, a condition of approximate self-guidance and responsibility was attained. The experience of the Idiot Asylum at Earlswood has demonstrated that even those deeply afflicted and imperfectly organized beings who are consigned to its care, may be made partially responsible, because, under certain conditions, they became invested with a certain portion of self-control.

We have said that in criminal cases, before the plea of

* We have cited these cases from *Roscoe's Digest*, edited by Granger.

† *Unsoundness of Mind in Relation to Criminal Acts*, by John Charles Bucknill, M.D., London. Highley, 1854. P. 115.

‡ *Haslam on Madness*. Second edition, p. 341.

insanity can be admitted, a large deficiency of self-control, resulting from disease, should either be proved, or shown to be reasonably inferred. In the celebrated case of Henriette Cornier, described at length by Georget,* a mild, lively girl, remarkably fond of children, became silent and melancholy in June, 1825, and finally sank into a kind of stupor. In September she attempted suicide. In October she entered the service of Madame Fournier, who could not dispel her dejection, and the girl would only talk of her misfortunes in losing her parents at an early age, and being ill-treated by a guardian. On the 4th of November she persuaded a Madame Belon to allow her to take her child—a little girl, for whom she had always evinced great fondness—for a walk, and having obtained possession of it, she cut its head off and threw it into the street, in order that the passengers might be attracted, and know she had done the deed. She stated that the idea had taken possession of her mind, and she was determined to do it. In such cases there is no difficulty in arguing the existence of insanity from the proof that the character of the patient had changed in a mode quite contrary to the known progress of *moral* depravity; but a commission of distinguished French physicians could not obtain proof of mental derangement by examining the girl after the offence. A second commission made a similar report, but added that their judgment could not be considered final if it could be proved that long before the 4th of November her character and habits had changed. Finally a jury found her guilty of "homicide without premeditation," and she was sentenced to hard labour for life. In this case an injustice was plainly done, because the court neglected to take sufficient cognizance of the conditions that preceded the offence; and it shows the necessity of inquiring into the previous life of an offender before rejecting the plea that he is insane.

In many instances in which the plea of insanity is set up, the offence is one likely to spring from moral depravity. It appears to have been instigated by motives likely to rule the conduct of wicked men, and it is in conformity with the general behaviour of the offender. Under such circumstances the plea of insanity is usually rejected, even though it can be shown that the prisoner's ideas on many subjects are very absurd. But extreme cases occur, in which many people would be disposed to accept the theory of insanity, although no disease could be shown. Pinel records a case,† in which the only son of a weak, indulgent mother was encouraged in the gratification of caprice and passion. The result was an ungovernable disposition, that grew with his years. He quarrelled savagely

* It is cited by Ray, *Jurisprudence and Insanity*, p. 198.
† Cited by Ray, p. 159.

upon the most trifling cause, assaulted his adversaries with fury, and would instantly kill any animal that offended him. When he came of age he was found competent to manage his estate, and was in some instances benevolent, but continually involved himself in ferocious strife, and finally killed a woman who used offensive language to him, by throwing her down a well. Similar cases, though milder in degree, often occur; and it would seem most consonant with reason to hold them as exhibitions of highly cultivated depravity, unless they can be accounted for by very plain and positive proof of disease. The paroxysms of rage exhibited by such persons differ widely from such instances as that of a lady who, up to the age of forty-three, was never known to manifest a passionate disposition, but, after the birth of her last child, was subject to overpowering fits of rage, excited by the most trifling causes.*

If good ground appears for believing that cerebral disease exists, it would seem proper that it should be held as very likely to have destroyed responsibility to a greater or less extent, even though its only traceable results were not obviously connected with the crime. Thus, if the disease was only known to have led to the delusion that an individual was made of glass, and his offence was forgery, it would be difficult to avoid the belief that the offender's self-control *might* have been lessened by the disorder, although we could not exactly tell how. In such cases, justice would object to an irreversible sentence like the death penalty formerly enacted for forgery in this country, or to a cruel punishment; but it would not necessarily object to a penal discipline directed towards the amendment of the patient, and accompanied by what medical treatment his case required.

The question will be asked, Would you then punish men who are not sane? The reply is necessarily a little complex. In the first place, no man, however sane, ought to be punished *brutally,* and if we omit the consideration of capital punishment, it will be universally conceded that no man ought to be compelled to undergo a secondary punishment that is not calculated, directly or indirectly, to promote his reformation.

No scientific man would deny Dr. Bucknill's statement concerning degrees of responsibility, and few would demur to the doctrine of a quotation which he makes from the fifth report of the Inspectors of Lunatic Asylums in Ireland, in which, after protesting against a morbid disposition to render lunacy the protector of crime, they say, "If there are extenuating circumstances connected with the psychological condition of the accused, they are legitimate subjects to be considered in meting out the after punishment, but certainly not in the first instance,

* *Obscure Diseases of Mind and Brain,* first edit., p. 179.

for an unqualified acquittal." It is not, however, a question of *punishment* only, but of the treatment most likely to amend its subject.

Unreasonable opinions should not too readily be allowed to lead to the inference of insanity as a disease; and certainly not when those opinions take a form quite consonant with the motives a criminal would be likely to cherish. Suppose after a murder, a man should say that he believed all people were blind instruments of fate, and it should be found that he had for many years represented himself as compelled to do whatever acts he performed. There would in this, be no indication of insanity, intellectual or moral. But if it could be shown that, after leading a life of average self-control, he had from a particular date believed himself impelled by a power he could not resist, there would at any rate appear very strong ground for inquiry whether he had fallen under the thraldom of a disease.

Judges have shown no disinclination to believe that disease may cause intellectual insanity; but the only form of moral insanity they have been willing to admit, is that non-existent kind, in which persons capable of cleverly concocted crimes are supposed incapable of knowing what the law deems right and wrong. Such errors show how exclusively professional tendencies may warp the mind, so that in particular directions it cannot see the plainest truth. If the brain be admitted to be the organ of animal propensities, moral faculties, and intellectual faculties, it is illogical to deny that its disorder may lead to an excess or a deficiency of action in any one of these departments, and from thence may arise a degree and kind of insanity, by which moral responsibility may be lessened to a greater or less extent. A state of general bodily health requires that there shall be a certain proportion between the rate at which work is done by the several organs of which our frame is composed. Too much vitality in the lungs or liver would disturb the condition of health, even though those organs did nothing wrong in kind. Thus looking to the body as a *whole*, it may be diseased simply by processes of supply and waste going on too fast or too slow in particular parts.

Physiologists have as yet failed to explain how the brain manages to do its multifarious work; but without presuming to map it out into distinct organs, we may believe that its healthy action as a *whole* requires an exact regulation of the rate at which its different parts undergo change, and thus there may be cerebral disorder without any obvious exhibition of inflammation, or other violent action. Microscopic investigation may ultimately throw much light upon these questions; but however obscure the nature of insanity may be, we must never

forget that we must treat it as belonging to *physical* inquiry; as *mind*, apart from organization, is utterly beyond the *medical* art, and is subject to higher powers than sit in earthly courts.

If the preceding facts and arguments are appreciated, we shall arrive at a few practical results. In the first place, we shall desire a change of our law in conformity with common sense; nor shall be diverted from this demand by a citation of a few decisions not quite so barbarous as those to which we have dircted attention. We shall require that the law shall take cognizance of any form of insanity that really exists, and that it shall admit the existence of degrees of responsibility.

In the next place, we should demand that the investigation and decision of an alleged case of insanity, being a highly difficult, and often complicated scientific process, should not be left to the accidental influence which highly-paid witnesses may have upon the minds of an imperfectly educated jury; but that, on the contrary, it should be an inquiry carefully conducted, by men who have no personal interest in its result, and who should be empowered to carry it as far back into the previous life of the accused as may be needful to arrive at a satisfactory conclusion. Thirdly, instances will occur in which it may not be practicable to determine the final disposition of the supposed criminal lunatic, until he has been for a considerable time under constant supervision, by which his actual state may be disclosed.

Lastly, we shall perceive that criminal lunatics will not form a class all of one sort. Some will be sincere objects of affectionate pity, while others, being more or less responsible, will deserve actual punishment as well as medical care.

CLUSTERS AND NEBULÆ.—DOUBLE STARS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

When Sirius, now so magnificent an object in our southern sky, is on the meridian, about 4° below him the eye will just catch a feeble, cloudy patch; this is—

15. 41 M (*Canis Majoris*). A beautiful, brilliant, and widely-extended group of 8 mag. and smaller stars; one of the brightest near the centre I found to be of an orange or ruddy hue; as has also been noted by H (No. 411). A remark of this great observer with respect to irregular clusters, that "it is no uncommon thing to find a very red star much brighter than the rest occupying a conspicuous situation in them," seems to be to a certain degree exemplified here. Some law is probably concerned in this arrangement, but of a nature to us utterly incomprehensible.

Sirius is nearly in a line between two smaller attendants, each at a distance of several degrees. The larger one lying *p*, a little *s*, is *β Canis Majoris*, 2 mag.; the other *f*, a little *n*, is *γ*, 4 mag. A line from Sirius to the latter star, carried on through the galaxy nearly twice as far again, and turned a little downward, will encounter a suspicious-looking district, of an indistinct, *clustery* aspect. This, the finder will turn into a succession of objects arranged in an irregular, and, on the whole, horizontal direction: a wide pair precedes; then comes a bright group visible to the naked eye; a much feebler nebula follows, a little *s*, with a star lying *s p*; then another pair less wide than the first. Each of these will repay our attention. We begin with the most conspicuous, the bright cluster. This is—

16. 38 Ḣ VIII (*Argûs*). A very splendid field of large and small stars, as Smyth well describes it, which should be viewed with a low magnifier: in the midst of it we shall at once recognize a very neat pair, whose data, according to him, are 8″, 303°·8, 7½ and 8, both bright bluish white. A little way *p* lies a bright star, about 6 mag., attended by a minute *comes n f*. This is now the *lucida* of the assemblage, although H., who numbers the cluster 459, does not mention it, and gives precedency to the double star. About ½° *p* lies a 5 mag. star, the more southerly of the wide pair which leads the whole region in the finder: it is worthy of notice from its fine fiery orange hue. The other smaller one, *n p*, seems greenish, perhaps from contrast. To gain an idea of the grandeur of the galaxy, we should sweep round the outskirts of this cluster, especially in a *n f* direction. "Lift up your eyes on high, and behold who hath

created these things, that bringeth out their host by number: He calleth them all by names, by the greatness of his might, for that He is strong in power, not one faileth." (Isaiah xl. 26.)

The next object in the district follows, a little *s*, looking nebulous in the finder. It is—

17. 46 M (*Argûs*). Described by Smyth as a noble assemblage of stars from 8 to 13 mag. This very beautiful cluster, of which the average seems about 10 mag., is nearly 30′ in diameter, and requires a large field. I have not succeeded in detecting a planetary nebula, which Smyth calls extremely faint, among the larger stars on its N. verge.

The star mentioned as standing *s p* from this cluster in the finder is of a fine orange colour. While examining this, or the previously-mentioned fiery star *p* 38 ♅ VIII, with a power of 64, Feb. 8, 1864, I found it so doubled for a few seconds by irregular refraction, that at the moment I believed it really was a close pair. (See Int. Obs., October, 1863, p. 194, for a detailed account of a similar illusion.)

The last object in this interesting region, a wide double star in the finder, is referred to the continuation of our Double Star List.

In the Intellectual Observer for May, 1862, at p. 277, are directions for finding the head of *Hydra*. Between this region and the one which we have just been exploring, but nearer to the former, and bearing a little to the S., is a star, the most conspicuous in its neighbourhood, which the finder represents as three in a line. From the absurdly perplexing way in which the outlines of the constellations have been arranged, the central and brightest star is given as 30 *Monocerotis*, while it is flanked by 1 and 2 *Hydræ*. We have, however, nothing to do with this ill-named group, excepting as a pointer to a cluster which lies *p*, a little *s*, at a distance of about 3°, and which is so extensive that it will be easily recognized as a faint cloud in the finder. Its synonym is—

18. 22 ♅ VI (*Monocerotis*). Smyth has termed this a splendid group in a rich region containing several small pairs. Its components, chiefly about 8 mag., are condensed in the centre into a lengthened patch of an irregular triangular or arrow-headed form. H., whose No. 496 it is, says that the stars are from the 9·10 to the 13 mag., and none below; "but the whole ground of the sky on which it stands is singularly dotted over with infinitely minute points;" invisible, of course, in any ordinary telescope.

DOUBLE STARS.

Our researches among the nebulæ enable us to add two more pairs to our list. The first is mentioned under No. 17

of the preceding catalogue, where a wide double star is spoken of as bringing up the rear of a group of interesting objects. The brighter of the two is 4 *Argûs*, a single yellowish 6 mag. star; the other will be easily decompounded into a beautiful pair:—

121. 2 *Argus*. 16″·8, 338°·8, 7 and 7½. Silvery white and pale white, 1836·2. I thought the smaller star bluish, 1851·19, 1864·1. This fine object is supposed to be stationary.

122. About 1½° to the S., a wide 7 mag. pair, not mentioned in the Bedford catalogue, is worthy of notice from the striking similarity of its components in size and hue—a deep orange. There can be no faith whatever in appearances, if these two peculiar looking individuals, insulated from any near neighbours, though projected accidentally as it seems upon a rich background in the distance, are not physically connected. Their aspect at once as much bespeaks their binary character as does that of 61 *Cygni*, and there is great probability that an investigation into their parallax and proper motion, as well as their distance and angle, would lead to an interesting result. Their situation, however, commends them preferably to the notice of southern observers.

OCCULTATIONS.

March 18. A^1 Cancri, 6 mag., will disappear at 6h. 58m., and re-appear at 7h. 57m. A^2 Cancri, a similar star, will follow it at 9h. 44m., and 11h. 4m. respectively.—19th. ω Leonis will be hidden from 6h. 11m. till 7h. 28m. See the remarks on the occultation of this star in Int. Obs., Dec. 1863, p. 352. The present is a more favourable opportunity for this curious observation, as the disappearance takes place at the dark limb; the position of the limb, compared with the position-angle of the two stars, seems also well adapted for a successive extinction of the light of each component.—27th. ω^1 Scorpii, 4½ mag., will disappear at 12h. 3m., and will remain invisible for 1h. 2m.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

MANCHESTER PHILOSOPHICAL SOCIETY.—*Jan.* 12.

On the Amount of Carbonic Acid existing in the Air of Manchester.—Mr. Roscoe related the results of numerous experiments made to ascertain the amount of carbonic acid existing in the air in and around Manchester. He found the maximum quantity on a foggy winter day, January 7, 1864, when the amount reached 5·6 vols. per 10,000 of air; the minimum amount, on Feb. 19, 1863, being 2·8 vols. per 10,000 of air; the mean of numerous experiments in the centre of the town giving 3·92 per 10,000, that of London being 3·7. Continuous rain was found to lower the amount from 4·8 to 3·3 volumes per 10,000.

These results show that under no circumstances does the amount of carbonic acid rise to 6 vols. per 10,000 of air, and that the mean quantity, nearly 3·92, closely agrees with that which is generally assumed to be the amount—namely, 4 vols.—this being the average, as obtained by Saussure's well-known investigations.

ETHNOLOGICAL SOCIETY.—*Jan.* 26, *and Feb.* 9.

The Varieties of Man in the Indian Archipelago.—Mr. Wallace read a valuable paper on this subject. He stated the animals of Borneo, Sumatra, and Java to correspond more or less closely with those of Asia; whilst the animals of New Guinea and the adjacent islands confirm the idea of their having been once connected with Australia. The two human races are as strongly marked in their diversity as the animals, Malays inhabiting the western and Papuans the eastern group.

Mr. Wallace accounted for the wide spread of the Oceanic race of the Polynesian Islands, by regarding these islands as being relics of a continent formerly existing in the Pacific, and that the present Polynesians are the descendants of the inhabitants of a continent now sunk beneath the ocean—a theory which is supported by numerous facts, both geological and zoological.

On the Ethnology of Australia, by M. A. Oldfield.—The author considered the New Hollanders to be mainly of Malay descent, which people, he supposes, colonized the northern shores of Australia, and their descendants to have spread lower eastward, over the continent, following, to a great extent, the lines marking the distribution of edible plants. The familiar customs of the various tribes evince a community of origin; but, as the migrations have been irregular, the migratory bands have crossed each other's lines, leaving their traces at the points of transit. That Australia was inhabited prior to its colonization by the Alfouras, seems probable, from the existence of relics of a civilization far higher than can be claimed

by any tribes of the Malay family. These remains of an extinct civilization consist chiefly of picture-caves and sculptured rocks, works which the present occupants of the soil, far from claiming as their own, ascribe to diabolical agency. As the features and dresses of the figures represented are such as no untutored savage could possibly conceive, and the tools and pigments used are unknown to the existing race, the only just inference we can draw from these facts is, that some more civilized people has been destroyed by the black man; or, possibly, in some instances, the two races have blended, a supposition that would enable us in some measure to account for diversities of characteristics found to exist in various localities. The anomalies for which we thus seek to account exist chiefly among the inland tribes, in which we occasionally meet with physiognomies departing widely from the Australian type; and, to reconcile the discrepancies, we are driven to suppose that the fact is owing to a mixture of the blood of a pristine race with that of the Alfoura; for, had this blending of races been due to the migration of strangers from the sea-board, traces of their presence would be equally perceptible along the lines of their journeyings. On the western and northern coasts, we find the greatest departures from the normal type; and this, doubtless, is owing to the advent of strangers among them: those shores bordering on much-frequented seas being more likely to have been visited by such than either the south or east coasts, which were, perhaps, never visited until European enterprise led the white man to them. One of the principal causes of the reduction of the aboriginal population is the scarcity of the larger kinds of game, consequent on the introduction of cattle and sheep into their country; for the continual tending of the flocks and herds, the frequent driving of them from place to place, but, above all, the constant passage of the stock-drivers, and the wanton havoc of the Europeans, all concur to scare the game, and eventually to drive it beyond the limits of the space assigned to the tribe in whose country these settlers have taken up their abodes; added to which, as such settlements are located in the most fertile parts, from which the natives draw the chief portion of their vegetable diet, it very soon happens that the aborigines find a scarcity of food; and, as the territorial boundaries of each tribe are well defined, they cannot retreat before the white invader; for to pass beyond their own limits would be to expose themselves to the hostility of some other tribe. After suffering hunger for a time, the natives are unable to resist the temptation of a feast on the cattle of the settlers; and, to avenge this act, an indiscriminate slaughter has too often been the policy of the European.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY.—*Jan.* 27.

ENTOZOA IN THE HUMAN BLOOD.—The Secretary read an extremely interesting paper by Dr. John Harley, of King's College Hospital, on a malady (hæmaturia) produced by a species of *Distoma* at the Cape of Good Hope and at the Mauritius. Dr. Harley, from an

examination of the parasite's eggs and embryos (obtained from his own and other patients) was led to believe that they were referable to a new kind of fluke, which he proposed to call *Distoma capense*.

Dr. Cobbold remarked that no person who had previously familiarized himself with the appearances presented by the eggs of the various distomes could doubt for a moment that Dr. John Harley's illustrations represented the ova of the so-called *Distoma hæmatobium*. In short, the symptoms, pathological products, eggs, and embryos described by Dr. Harley, all tended to show that this hæmaturia of the Cape was identical with the well-known Egyptian malady. Dr. Harley's discovery was, however, a most important one in relation to the geographical distribution and prevalence of entozootic diseases; for the author had now demonstrated, in a most satisfactory and able manner, that the helminthiasis in question was not confined to Egypt, as had hitherto been supposed, but was more or less prevalent in Southern Africa and in the Mauritius. Speaking zoologically, this parasite was not a true distome, as it represented the type of a distinct genus, to which Diesing, of Vienna, gave the name of *Gynæcophorus;* Weinland, of Frankfort, had called *Schistosoma;* Moquin-Tandon had denominated *Thecosoma;* and himself had previously entitled *Bilharzia,* after the name of the original discoverer, Dr. Bilharz, of Cairo. He (Dr. Cobbold) had discovered this so-called *Distoma hæmatobium* in the portal blood of an African monkey (*Cercopithecus fuliginosus*) six months before Diesing had communicated his paper to the Vienna Academy, and, therefore, he hoped Dr. Harley (in concert with Weinland and others) would retain the generic name *Bilharzia,* which had the priority. At all events, this was not a new species of fluke, and, therefore, the name *Distoma capense* could not stand. But Dr. Harley's discovery was none the less important on this account. It was quite clear to him (Dr. Cobbold) that our fellow men at the Cape, in the Mauritius, on the banks of the Nile, and also, if you please, our friends, the monkeys, obtained this parasite by swallowing the "intermediate bearers" of the Bilharzia. These "bearers" or "hosts" were small mollusks or aquatic animals, inhabiting the African rivers. They contained the higher larval states of this parasite, the larvæ being introduced into the human body by drinking the African waters unfiltered.

ENTOMOLOGICAL SOCIETY.—*Feb.* 1.

Probable New Source of Silk.—Professor Westwood showed samples of a peculiar silk forwarded from St. Salvador, South America, said to be produced by larva feeding on a native species of oak (Quercus). The silk, which is produced in flat layers, and not in cocoons, is said to be of good quality, and to be capable, after carding, of being used in the arts.

Mr. F. Smith showed a curious collection of wasps' nests, in every stage of progress, from their first commencement to their completion. All of these had been constructed under the direct superintendence of Mr. Stone, who has so far succeeded in domesticating wasps as to be able to induce them to construct their nests in any situation that he wishes.

GEOLOGICAL SOCIETY.—*Feb.* 3 *and Feb.* 19.

THE PERMIAN ROCKS OF THE NORTH-WEST OF ENGLAND.—Sir R. I. Murchison and Professor R. Harkness communicated a paper on the Permian group, in which they propounded a new view of their composition; and, by the consequent re-arrangement of the rocks involved in this change in classification, they were enabled to place the Permian strata of Great Britain in direct correlation with those of the continent of Europe. This new feature in British classification is the assignment of a large amount of red sandstone in the north-western counties to the Permian period, and its removal from the New Red Sandstone, or Trias-formation, to which they have hitherto been assigned in all geological maps. The authors showed that these red sandstones are closely and conformably united with the Magnesian Limestone, or its equivalent, and form the natural upper limit of the Palæozoic deposits. They thus affirmed that a tripartite arrangement of the Permian rocks holds good in Westmoreland, Cumberland, and Lancashire, and that the three subdivisions are correlative with those formerly shown by Sir R. I. Murchison to exist in the Permian deposits of Germany and Russia.

The difference in lithological details of the Permian rocks of the North-West of England from those on the opposite flank of the Pennine chain was next adverted to; and it was observed that, with so vast a dissimilarity in their lithological development in England, we need not be surprised at finding still greater diversities in these protean deposits, when followed into Germany and Russia.

The discovery, by Professor Harkness, in the central member of this siliceous group in Westmoreland, of numerous fossil plants identical with the species of the Kupfer Schiefer in Germany, and in the Marl-slate of the Magnesian Limestone of Durham, was given as a strong proof of the correctness of the authors' conclusions.

On the 19th Feb. Professor Ramsay delivered an annual address of unusual interest and importance. The subject was a continuation of that of last year, and the learned Professor went into an elaborate investigation of the evidence that great breaks existed in the biological and stratigraphical record presented by the secondary formations in this and other countries. When the address is published it will, no doubt, receive further notice in the INTELLECTUAL OBSERVER; and all that our present space and opportunity permits is to say that an investigation of all the known facts concerning the secondary, or Mesozoic, strata, confirms the views expressed by Professor Ramsay, and coupled by the leading geologists, with reference to the Palæozoic rocks,—namely, the incompleteness of the record, and the strong probability that the whole series of changes in the life of the globe have been brought about by the very slow and gradual action of causes operating through enormous periods of time. Professor Ramsay laid before the Society carefully prepared tables, to show the proportion of species that can be traced upwards and downwards from particular secondary formations. These tables show the changes, of which known rocks furnish the records, to be more gradual than has generally been supposed; and, if we make

allowance for the loss or non-discovery of so many pages in the great Stone Book, the idea of a series of alternate creations and destructions must give place, to make way for a continuous picture of descent with modifications, and a replacement of species by causes analogous to those which affect the fauna of our own times.

NOTES AND MEMORANDA.

New Facts in Fermentation.—M. A. Béchamp states in *Comptes Rendus* that if the must of grapes of different kinds is filtered, the ordinary alcoholic ferment (yeast) only appears in it; but, if not filtered, thread-shaped ferments make their appearance also, and occur largely with free access of air. The fermentation of filtered grape juice effected by yeast only, yields a wine that differs considerably from that of unfiltered grape juice fermented in the ordinary way. He cannot state exactly what part is performed by the filiform (vibrio-like?) ferments, but does not find that they materially augment the quantity of acetic acid in the wine.

Shooting-Stars in the Two Hemispheres.—M. Poey, in a paper communicated to the French Academy on the Shooting-Stars he had observed at Havannah, states that the number of meteors seen in the Northern Hemisphere is nearly double that of those seen in the Southern; and that, while in the Northern the maximum number is seen between one and two o'clock, in the Southern the greater part are seen between two and three.

Spontaneous Generation Committee.—At the sitting of the French Academy on January 4th, M. Pasteur stated that Messrs. Pouchet and Joly denied his assertion, "that it was always possible to take from any place a noticeable, but limited quantity of air, which had not undergone any modification, chemical or mechanical, and which was, nevertheless, unfit to cause any alteration in an eminently putrescible liquid." MM. Joly and Musset declared that if, under such circumstances a single vessel remained unaltered, they would acknowledge their defeat. M. Pouchet said, "I affirm that, from whatever part of the globe I take a cubic decimetre of air, when I place it in contact with a fermentable liquor enclosed in a hermetically sealed vessel, it is always filled with living organisms." All the parties were willing to repeat their experiments before a Commission named by the Academy, and accordingly Messrs. Flourens, Dumas, Brongniart, Milne Edwards, and Balard were nominated for the purpose.

Aniline Yellow and Aniline Blue.—Professor Hoffman has communicated to the Royal Society his observations on a yellow substance obtained by Mr. Nicholson from a resinous substance left in the preparation of rosaniline. Professor Hoffman calls this material *chrysaniline*, and states that it is a finely-divided yellow powder, like fresh precipitated chromate of lead, uncrystalline, scarcely soluble in water, easily so in alcohol and ether. It constitutes an organic base, represented by the formula $C_{20}H_{17}N_3$.

To form *Aniline blue*, rosaniline salts are heated at a high temperature with excess of aniline, or rosaniline is so heated with salts of aniline. The transition was first observed by MM. Gerard and DeLaire, and has become the foundation of a new branch of industry.

The Climbing Anabas.—Some doubt having been thrown on the climbing properties of this curious fish (*Anabas scandens*), Captain Jesse Mitchell, of the Madras Government Central Museum, states in the *Annals Nat. Hist.* that his assistant, Mr. Rungasaway Moodeliar, has seen it climb palmyra trees growing by the side of a tank or pool. The fish climbs by means of its opercula, which move unlike those of other fish. It crawls up the tree sideways to the height of five or seven feet, and then drops down.

Illustration of Negative Evidence.—Many disputes in geology are founded upon the generally unwarrantable assumption that certain animals or

plants could never have existed, because their remains have not been found. It is, therefore, interesting to note a modern instance, in which naturalists are without that kind of proof, furnished by a specimen, of the existence of an enormous animal, apparently not uncommon. Dr. Gray, speaking of the Physetes, or Black fish of the whalers, states in the *Annals Nat. Hist.*, "there is not a bone, nor even a fragment of a bone, nor any part which can be proved to have belonged to a specimen of this gigantic animal to be seen in any museum in Europe. This is the more remarkable, as the animal grows to the length of more than fifty feet, is mentioned under the name of the Black fish in almost all whaling voyages, and two specimens of it were examined by Sibbold, having occurred on the coast of Scotland."

The Nile in Early Ages.—The *Quarterly Journal of the Geological Society*, No. 77, contains an important paper by Dr. Leith Adams, who has been collecting fresh-water shells in the Nile Valley at considerable elevations above the present river level in flood seasons. The conclusions deduced from his observations are "that there is reason to infer that the Nile in early ages was a rapid river, and that the force of the stream has been steadily declining; at least, since the upheaval (?) of the valley ceased." Dr. Adams adds that Mr. Rhind's observations tend to show that "the change has been scarcely perceptible within the long historical periods furnished by the records, excepting on certain points caused by a change in the direction of the river's force."

Artificial Rainbow.—M. J. Duboscq has contrived for the French theatre a method of imitating the rainbow, of which *Cosmos* speaks very highly. He employs an electric light, obtained with the aid of 100 Bunsen elements. The first lenses of his optical apparatus render the rays from this source parallel, and transmit them through a rainbow-shaped hole in a screen to a double convex lens of very short focus, from which they pass to a prism, and emerge with sufficient divergence to make an effective rainbow on a screen about six yards off. This rainbow is said to be brilliant even when the whole scene is lit up.

An "Aerial Navigation Society."—A society under this title has been constituted in Paris, to assist the experiments of M. Nadar, and promote atmospheric travelling.

Electrical Light at Cape de la Hève.—The French government has maintained an electrical illumination at this lighthouse, which is near Havre, since 26th December.

Industrial Education of Spiders.—M. Duchesne Thoureau has forwarded to *Cosmos* a specimen of a sort of felt produced by spiders in confinement, and he states that a sufficient number of these creatures placed under conditions of domestication, which he does not explain, will make soft, warm carpets of any size! The editor of *Cosmos* says that the specimen of spider manufacture sent to him is like German tinder in appearance.

Preservation of Meat.—M. Pagliuri has sent a note to the French Academy on his method of preserving meat. He washes it over with a liquid composed of alum, benzoin, and water, this leaves a film of a protecting substance, which he states permits evaporation to go on, but prevents the access of the ferments of putrefaction. Specimens of the preserved meat were exhibited, but they are said not to have presented a very enticing appearance.

Injection of Oxygen into Veins.—M. M. Demarquay and Lecompte have shewn that considerable quantities of oxygen may be thrown into the *vena cava* below the liver, or into the *vena porta*, without killing an animal and without changing the colour of venous blood.—*Comptes Rendus*, *No.* 4. 1864.

EGG PARASITES.

1, 2, 3, 4, 5, 6, *Saprolegnia ferax*. 7, *S. monoica*. 8, 9, *S. dioica*.
10, 11, 12, *Achlya prolifera*. 13, 14, *A. dioica*. 14ª, 15, 16, *Pythium monospermum*.
17, 18, 19, 20, *Aphanomyces stellatus*.

[illegible]

[illegible]

[illegible]

[illegible] remarks to [illegible]

[illegible] I— [illegible]

[illegible] them [illegible]

[illegible] this [illegible]

THE INTELLECTUAL OBSERVER.

APRIL, 1864.

EGG PARASITES AND THEIR RELATIVES.

BY THE REV. M. J. BERKELEY, M.A., F.L.S.

(*With a Tinted Plate.*)

ALMOST every one who is engaged in experiments on the development of the ova of fishes, at the present moment quite a fashionable employment, complains that they are subject to the attacks of some parasite, which effectually destroys their vitality.

Various parasites indeed occasionally infest them, such as green confervæ, belonging to the genus *Œdogonium* and others; but there is an especial group of organisms variously assigned to Fungi and Algæ, which are notoriously antagonistic to animals, especially those of aquatic habits, in a low stage of vitality. Flies are attacked by them while still alive, and so are our aquatic mollusca, but not only these smaller beings, but fish of considerable size often fall a prey to them, as is well known to those who have aquaria, and as we have ourselves witnessed at the London Zoological Gardens, and elsewhere. It is one or more of these organisms which attack the ova of our trout, salmon, and char, and therefore a few words about them at the present moment can scarcely be unacceptable.

It is now more than forty years ago since these productions were tolerably well characterised, and one of their most prominent features detected; but it is only of later years that they have been thoroughly investigated. Some of the group are parasitic on confervæ and other aquatic plants, but we shall confine our remarks to the genera *Achlya, Saprolegnia, Pythia,* and *Aphanomyces,* so far as they affect animal substances.

Gruithuisen appears to have been the first person who observed in the clavate tips of the threads of one of them, *Saprolegnia ferax* (Figs. 1—6), a multitude of minute spore-like bodies, which escaped from them and moved about when free like Infusoria. This observation, on which the genus *Sapro-*

legnia was first established by Nees von Esenbeck, has been now extended with certain modifications to the whole group; and on this account, in addition to their aquatic habits, these plants have been associated with the Algæ, though their appearance and habit are rather those of some of the moulds. Carus, however, in investigating a mouldy appearance which arose on a dead salamander, having immersed half in water and kept the other half moist in air, obtained from the latter an undoubted species of Mucor, while from the former he obtained *Achlya prolifera*, Nees (Figs. 10—12). This was taken at the time as a strong argument for the instability of the lower plants, while in truth it was only one amongst many proofs of a fact which was then unknown, but has since been amply manifested, that in these lower plants there is a duality or plurality of modes of fructification. Indeed, though the active spores, moving about with one or more lash-like appendages, resemble exactly the reproductive bodies which are so common amongst Algæ, there is now evidence amongst moulds, as in the genera *Peronospora* and *Cystopus*, and still more amongst the *Myxogastres*, that there are active spores amongst true Fungi. The difficulty, therefore, in great measure, ceases, and I have not a doubt left in my own mind about the subject, while I consider my remarks in the introduction to *Cryptogamic Botany*, which have been called in question, fully confirmed.

Correct information as to the structure of these curious parasites has been obtained but slowly, and as it is scattered up and down amongst a variety of journals, it is proposed to give here a sort of *précis*, without any pretensions to novelty. The most complete account is that by Pringsheim, in his *Journal of Scientific Botany*.* His definition of three of the genera to which these animal parasites are referrible is here given nearly in his own terms, to which is added a fourth, *Aphanomyces*, proposed by De Bary.

Saprolegnia, Nees v. Esenb.—Infusorioid spores formed in the interior of the sporangia, and immediately after their formation isolated and active without any previous membrane. New sporangia formed by the repeated protrusion of the basal membrane into the old sporangium. Oögonia containing numerous resting spores. (Figs. 1—8.)

Achlya, Nees v. Esenb.—Infusorioid spores formed in the interior of the sporangia, but after their formation collected in a head at the point of issue, and clothed with a membrane. The basal membrane of the sporangia forming lateral sporangia by protrusion at the base of the primary sporangia. Resting spores numerous in the Oögonia. (Figs. 10—14.)

* Jahrbucher fur Wissenshaftliche Botanik herausgegeben von Dr. N. Pringsheim, 1857 and 1589.

Pythium, Pringsheim.—Infusorioid spores formed at the orifice of the sporangia from their ejected contents, not surrounded by a membrane. Basal membrane neither prolonged into the cavity of the sporangium nor bursting out laterally. Oögonia containing a single resting spore. (Figs. 14—16.)

Aphanomyces, De Bary.—Infusorioid spores formed in a single row in long cylindrical tubes, collected in heads after their discharge, and acquiring a membrane before becoming free. Resting spores single in the Oögonia. Antheridia formed from the swollen tips of lateral branches. (Figs. 17—20.)

The parasite I have more especially seen on fish eggs belongs to the first genus, but as it has produced sporangia only, it is scarcely possible to speak positively as to the species, though I believe it to be referrible to *Saprolegnia ferax*.

To make this history more intelligible I will describe one or more species of each genus, in the course of which the technical terms used above will appear more clear.

The first appearance of *Saprolegnia monoica*, as indeed also of *S. ferax*, is that of delicate white or greyish, nearly equal, simple or slightly-branched threads, without any joints, radiating in every direction, and containing a grumous granulated mass. The tips of these threads gradually swell, and after a time a septum is formed at the base, after which the contents are collected into little pellets, each of which, at length, is separated from the rest, and becomes an ovate spore (Fig. 3), which escapes by a little aperture at the tip, and is furnished with one or two delicate thread-like appendages, by means of which it is able to move about like an infusorial animal with great rapidity. After a short time motion ceases, and the spore germinates and produces a new plant. (Fig. 4.)

After the sporangium is exhausted the septum at the base becomes convex, pushes forward (Fig. 2) into the vacant cavity, which it more or less completely fills, and produces another crop of spores, sometimes projecting through the aperture of that which was first formed. This process is repeated a third or even a fourth time till the powers of vegetation are exhausted.

Now, however, a second form of fruit (Fig. 5) appears. A form which has been called an Oögonium, because it produces spores which are quiescent and dormant for a time like eggs, and not furnished with motile appendages. Lateral branches are given off for their production, which terminate in large globose sacs, which, like the sporangia, are not at first separated by any septum. One, however, is at length formed, and the membrane becomes pierced with numerous apertures. Meanwhile other branches (as in *S. monoica*) spring up in their neighbourhood, the tips of which swell, and at length become

antheridia filled with granules, which seem to have the power of impregnating the contents of the Oögonia (Fig. 7). Processes from the antheridia enter the apertures (Fig. 6) in the walls of the Oögonia, the contents of which are soon transformed into numerous large globose resting spores. These like the others have the power of propagating the plant, and, like the resting spores of some other Algæ, are able to exist some months without vegetating, though occasionally they germinate *in situ*. As regards the vegetation in general, it proceeds with the utmost rapidity, so that constant attention is necessary to follow out the several phases satisfactorily.

In *Saprolegnia ferax* the first stage is precisely the same, but there are no lateral branches by the contents of the tips of which the Oögonia can be impregnated (Fig. 5). This is the case also in some other species, in which impregnation takes place by means of antheridia produced within the Oögonia, or bodies resembling the Oögonia in form, or by antheridia produced on certain threads, which after a time become free, and attach themselves to the Oögonia, as in some genera of Algæ, where they are called by the Germans Männchen, a term equivalent to Homunculi. The different species are, however, not at present perfectly characterised, and Pringsheim, who has paid so much attention to these productions, and to whom we are indebted for the greater part of our information, does not profess to have placed every particular beyond doubt.

In *Saprolegnia dioica*, however, he has shown that, after the power of forming sporangia has been exhausted, a new crop of threads springs up from the matrix, destined to produce the antheridia. The upper portions of these threads (Fig. 8) becomes septate, and commencing with the uppermost joint the contents become organized and re-transformed into myriads of minute bodies (Fig. 9), each of which bears a single thread-like appendage. These bodies are ejected from a terminal papilla, but in the succeeding joints the point of egress is lateral. They do not germinate like the infusorioid spores, and, as there seems to be no other mode of impregnation, it is conjectured that they pass through the apertures of the Oögonia, and thus vivify the resting spores.

Saprolegnia ferax is extremely common on flies in autumn, and may at almost any time be procured for examination by simply placing a few of the languid flies which are so common towards the close of the year in water.

Achlya prolifera (Figs. 10—12) will, however, sometimes appear on the same matrix, and possibly on other animal substances also.

The first stage of this plant is very like that of *Saprolegnia*, at least up to the formation of the first septum at the base of

the clublike end of the threads. The contents, however, of the joint when differentiated are not at once discharged as perfect infusorioid spores, but are collected in a globular head (Fig. 10) at the point of issue, where, after a time, each individual acquires a membrane, through which (Fig. 11) the spore at length bursts and moves about by the means of two appendages (Fig. 12).

The portion below the effete joint does not, as in the former case, push forward into the cavity, but bursts laterally through the walls, and as this process is repeated we have a forked thread.

The Oögonia are formed, as in *Saprolegnia ferax*, without any lateral branches, and, as in that plant, its walls are perforated with numerous holes. The antheridia in this species are, we believe, unknown, but in a closely allied species, *A. dioica,* they are produced, as in *Saprolegnia dioica,* on distinct threads (Fig. 13) thrown up from the base of the tuft after the sporangia have been formed. The threads are articulated in the same way, and, commencing with the upper joint, the contents are transformed into a number of globose antheridia, each of which gives rise to a quantity of uniciliate bodies (Fig. 14), which escape from the common aperture, leaving the mother cells behind. The process is repeated till it extends to four of five joints. The minute bodies do not germinate, and, therefore, as in the case of *S. dioica,* there seems little doubt about their functions.

We next come to *Pythium,* one species of which, *P. monospermum* (Figs. 14*, 16), grows on dead insects in water.

In this species the sporangia, which are produced on short lateral branches, are solitary and extremely long (Fig. 14*), with one, or sometimes two, shorter delicate appendages at their base. The contents ooze out and form a globular mass (Fig. 15) at the apex, in the centre of which the infusorioid spores are formed. The Oögonia are small and globose, and with or without a terminal thread or papilla; lateral threads are given off in their neighbourhood, the tips of which swell into antheridia and penetrate the Oögonium through one of its apertures by means of little rootlike processes, as in *Saprolegnia monoica* (Fig. 7), thus giving rise to a solitary resting spore (Fig. 16).

We have still to notice the fourth genus, which has been proposed by De Bary under the name of *Aphanomyces* (Figs. 17—20), a name which seems to imply a close affinity with Fungi, if not an immediate relation. Three of the species described grow upon insects in water. This genus is distinguished from the last by the peculiar mode in which the infusorioid bodies are formed. Each is produced separately from the contents of the thread, and as one escapes another comes forward from behind

(Fig. 17). When all have emerged each gradually acquires a separate membrane (Fig. 18), from which it ultimately escapes, moving about with one or two cilia (Fig. 19). The Oögonia are globose. Impregnation takes place by means of antheridia produced at the tips of lateral branches, as in *Pythium*. In *Aphanomyces stellatus* the Oögonia are covered with projecting papillæ (Fig. 20). In *A. scaber* they are much less rough, while in *A. lævis* they are quite destitute of warts. A single resting spore only is formed in each sac.

It remains only to notice a curious circumstance that, in an unnamed species of *Saprolegnia,* Pringsheim has occasionally found a single echinulate body formed within the Oögonium, reminding one at once of the similar bodies observed by Caspary and others, which are formed as a second kind of fruit in *Peronospora*. Cienkowski has also observed something very similar. This appears to be an additional argument for the reference of these curious bodies to Fungi. Attention also may be called to the close resemblance of the process of impregnation in *Saprolegnia dioica* to that which Hofmeister is said to have observed in Truffles (Pringsh. Jahr. Band 2), and still more to De Bary's observations on *Cystopus* and *Peronospora,* in the 20th volume of the fourth series of *Annales des Sciences Naturelles,* just published, and of which I shall hope shortly to give a report in the INTELLECTUAL OBSERVER.

If I am asked to propose a remedy for the disease, I am unable to make any plausible suggestion, as the substances which might prove an impediment to the production of these plants may prove equally detrimental to the eggs or fish which it is wished to protect. I can only suggest that a weak solution of hyposulphite of soda should be tried in the case of a few eggs, and, if it succeeds on a small scale, the experiment might be easily extended. No one would be rash enough to risk any great loss on a first experiment.

The following are the principal treatises which have been examined in the preparation of this paper:—Gruithuisen in Act. Leop. 1821, p. 450, t. 38. Carus in Act. Leop. 1823, t. 58. Pringsheim, Nov. Act. 1850, t. 46—50. Thuret Recherches sur les Zoospores des Algues, 1851. De Bary Beitrag zur Kenntniss der Achlya prolifera Botanische Zeitung, 1852. Cienkowski Algologische Studien Bot. Zeit. 1855. Pringsheim in Pringsheim Jahrb. Band 1, Heft 2. Pringsheim Band 2, Heft 2. De Bary in Pringsh. Jahrb. Band 2, Heft 2.

DESCRIPTIONS OF FIGURES.

Figs. 1—6. *Saprolegnia ferax.*—1. Group of threads with sporangia in different stages of growth, magnified. 2. Forma-

tion of second sporangium. 3. Infusorioid spore highly magnified. 4. Do. do. in germination. 5. Oögonia in various stages, magnified. 6. Portion of wall to show the apertures.

7. *Saprolegnia monoica.*—Oögonium with antheridia, one of which has penetrated the cavity by means of a rootlike process.

8, 9. *Saprolegnia dioica.*—8. Thread magnified, producing spermatozoids. 9. Spermatozoid highly magnified, killed with iodine.

10—12. *Achlya prolifera.*—10. Tip of thread, showing the infusorioid spores making their way to the tip of sporangium, and new sporangium formed at the base. 11. Infusorioid spores surrounded by membrane, and two empty cases, highly magnified. 12. Perfect spores free, highly magnified.

13, 14. *Achlya dioica.*—13. Tip of thread containing antheridia, from some of which the spermatozoids are escaping. 14. Spermatozoids, killed with iodine, highly magnified.

14*—16. *Pythium monospermum.*—14.* Thread with sporangia magnified. 15. Infusorioid spores collected at tip of a sporangium, highly magnified. 16. Oögonium with antheridium.

17—20. *Aphanomyces stellatus.*—17. Thread showing the spores making their way, one by one, to the tip. 18. Spores surrounded by membrane and empty cases. 19. Do. free. 20. Oögonia with antheridia.

The figures are all borrowed, with a single exception, from the above-mentioned memoirs.

PHOTOGRAPHY—ITS HISTORY, POSITION, AND PROSPECTS.

PART I.—HISTORY OF PHOTOGRAPHY.†

BY J. W. M'GAULEY.

In treating of a science which, although the creation of but a comparatively recent period, has become so extensive as to be dependent on an immense number of principles, to include a great variety of processes, and to be scattered over a vast body of literature in every modern language, it will be impossible, even in a paper of unusual dimensions, to give more than a glance at its past history, its present position, and its future prospects. It is not our object to teach the Art of Photography, we propose merely to trace its progress from its first glimmerings to its now wondrous development; to give a

† The remaining parts will follow at early dates.

short general view of its most important processes; to explain the most interesting of the principles on which its manipulations are founded; and finally to notice some of the accidents and failures to which it is liable. Although it is almost impossible to keep these perfectly distinct, it is more convenient to treat them separately.

Photography (light writing) enables us to produce pictures by means of the sun's rays, nevertheless its designation has not been happily chosen. Niepce very early suggested the term *Heliography* (sun writing), which would be far less open to objection; but it was not adopted: and the name, like many others which are unfortunately found in science, and were formed under the dangerous guidance of imperfect knowledge, is likely to maintain its position. It is not improbable, however, that it may yet be appropriate, since the day appears not very remote when even the various coloured rays will be compelled to leave their characteristic and permanent impress, and the photograph will become a picture in the truest sense of the word.

History of Photography. Photography originated in, and its chief processes still are—as perhaps they always will be—founded on the fact that the salts of silver are blackened by light. This, although so recently utilized, is not a new discovery. So early as the middle of the fifteenth century the alchymists had observed the blackening of fused chloride of silver; and they even considered the "sulphurous principle" of light, as they termed it, one of the chief agents through which nature received her variety of form. This extraordinary property of light continued, at least from time to time, to arrest the attention of philosophers, but the progress of its investigation was long and tedious. In 1777, Scheele concluded from his experiments that the dark tint produced was due to "reduced silver"; and he remarked that the violet acted more energetically than any other ray. In 1801, Ritter observed that a silver salt was blackened in a space beyond the violet of the spectrum, and that the red ray restored the reduced chloride. Then, it was discovered that the action of light was not confined to argentiferous compounds; Wollaston, in 1802, ascertained that cards moistened with tincture of gum guiaiacum acquired a green tint in the violet ray, but lost it in the red. In 1810, Seebeck noticed that the tints produced by light on chloride of silver were different with the different coloured rays; violet rendering it violet; blue, blue; yellow, white; and red, red. This was the first approximation to *Heliochromy*. Berard perceived that, when the rays of the spectrum, from the green to the extremity of the red, were concentrated by a lens, chloride of silver, exposed in the focus for more than two hours,

suffered no perceptible alteration, although the light was too brilliant for endurance; but that it was blackened in six minutes, when it was exposed, in a similar way, to the rays between the green and the extremity of the violet. Philosophers are now aware that the solar spectrum in reality consists of three spectra, possessing very different properties, partially, but not uniformly, superimposed—a luminous, a calorific, and an actinic; photographic effects being due to the last; and that the luminous consists of a yellow, a red, and a blue spectrum, similarly superimposed. Whether the calorific and the actinic also are compound, our present knowledge does not enable us to decide.

The important circumstance of the action of light on a salt of silver having once attracted attention, such a modification of the effect as would result in a picture was but a step, though an important one. This step is due to the combined ingenuity of Wedgewood, the son of the celebrated porcelain manufacturer, and Sir H. Davy, the illustrious chemist. The effects they produced excited admiration, but their pictures gradually changed into mere blackened surfaces. The knowledge of one simple fact alone was required to give permanence to their productions; but that fact was not discovered until long afterwards. These achievements of Wedgewood and Davy had been, in some degree, anticipated more than two centuries previously; since Fabricius, in a work on metals, published in 1566, asserted that a lens produced on chloride of silver an image in which the bright parts of objects formed dark shadows, and their dark parts lights—that is, a "negative picture," the lights and shades being reversed. Such were the pictures of Wedgewood and Davy, since they were unable to obtain a positive by transmitting the light through a negative. At this stage, the camera obscura naturally suggested itself as a valuable aid to photography; but, when Wedgewood made the trial, he found that too long an exposure to light was required, if it was used. The solar microscope, however, was found to be available for the purpose; but he usually employed the direct rays of the sun, transmitted through the engraving, or other object which it was desired to copy. Wedgewood discovered that the chloride was more sensitive than the nitrate of silver, and that both were more sensitive in the moist than in the dry state.

Little or no further progress was made for some time; but at length the grand difficulty was surmounted; Niepce and Daguerre succeeded in *arresting* the action of light. Nicephorus Niepce was born at Chalons-sur-Saône, in 1765. In his early years he had been in the army, but in 1814 his attention was accidentally turned to photography. Seeking a substitute for lithographic stone, he observed that bitumen was rendered of

a greyish colour by the action of light; and that if spread as a thin coating over a metallic plate, and exposed to the light, it was rendered soluble in essence of lavender, wherever the light had acted. He advanced then step by step to important results, Daguerre being, during the latter portion of his career, the partner of his researches. But he did not himself reap the reward of his labours, since he died in poverty in 1833, having dissipated his patrimony in scientific investigations. When, however, in 1839, the discoveries made conjointly by him and Daguerre were purchased by the French Government, and given to the world, his son was not forgotten. Louis-Jaques-Maudé Daguerre, a celebrated French artist, was born at Corneilles, in 1789. His early life was passed in stormy times, but this did not prevent him from devoting himself to his profession and becoming very eminent as a scenic decorator and a painter of dioramas. While attending a course of chemistry under Charles, with the purpose of calling that science to the aid of his pencil, he was struck by a remark made by the lecturer, when he exhibited to his audience an image produced by means of a salt of silver—"it is the sun that has drawn this portrait." Again and again Daguerre repeated these words to himself, but each time he was obliged to add, "it does not last." He was resolved, however, to give it permanence; and, in the researches he undertook for the purpose, availed himself of the improvements which had lately been made in the camera. He did not die until 1851, long after his labours had been crowned with success.

The attempt to arrest the action of light had occupied the attention of Niepce from 1814 to 1824, with but little result. Towards the close of this period, his brother, a colonel in the French army, while making some purchases of Chevalier, the eminent optician, happened to remark that Niepce had succeeded in fixing the image produced by the camera; but Chevalier discrediting the assertion, paid no attention to it. And when, some days after, Daguerre called upon Chevalier, and announced a similar discovery, he looked upon it merely as a continuation of the same pleasantry. But at length, finding that Daguerre was in earnest, he gave him such information regarding Niepce, as produced a correspondence between the two experimentalists, that ended in their becoming partners; and before the close of 1827 considerable progress was made by them in the attainment of an effective mode of fixation.

Niepce's object was, originally, the multiplication of images; which he sought to accomplish by coating a metallic plate with bitumen, exposing it to the action of light, dissolving off the coating where the actinic influence had rendered it soluble, and then corroding with nitric acid those parts which had thus

been denuded. This process was ultimately modified so as to be applicable to photography. Daguerre also used a metallic plate; but his object was to form a single picture directly upon it. The last step made by Niepce was the substitution of iodine for a resinous coating, which diminished the time required for exposure from hours to minutes. He died soon after, and his son Isidore became the partner of Niepce. In 1839 the fruit of all their joint researches was given to the world. Twelve days after the Chamber of Deputies had voted their well earned rewards to those who may be said to have created photography, Daguerre lost, by a conflagration, the results of all his labours as an artist; but the reputation he had acquired enabled him to recover from the effects of this calamity, and he thenceforward devoted himself to philosophy.

At first, the Daguerreotype process was extremely slow, an hour being required for a portrait; but the use of bromine, introduced by Goddard in 1840, and of other accelerating materials, greatly abbreviated it. The removal of the undecomposed silver salt, by means of hyposulphite of soda, constituted its most important feature, as it was this which prevented the darkening of the picture. But Sir J. Herschel also discovered this important property of the hyposulphite, though unknown to Daguerre. The Daguerreotype process has, for several reasons, been practically abandoned.

It is a curious circumstance that, while Niepce and Daguerre were occupied with their experiments, a young man who was quite unknown to Chevalier showed him some photographic positives on paper, expressing his conviction that with a better apparatus than he possessed he would produce still greater results, but avowing his inability to purchase one. He left some of the material he had used that it might be tested by experiment, but neither Chevalier nor Daguerre were able to accomplish anything with it. He never returned, and remains unknown. But for his poverty he would perhaps have been the successful rival of Niepce and Daguerre.

Six months before the Daguerreotype process was published, Fox Talbot, who had been engaged in his researches since 1834, and had succeeded in fixing the picture, communicated to the Royal Society his photographic discoveries, and immediately after made known his method of preparing sensitive paper. He was betrayed by one of his assistants, who sold the secret of his process to a photographic society at Lille, where some good pictures were produced by means of it. Talbot was the first who successfully used paper rendered sensitive with chloride of silver. He observed not only that different papers similarly prepared vary in sensibility from very slight causes, but that some portions of the same paper, even when most

carefully prepared, may be found quite insensible. He claimed a patent right in the use of gallic acid as a most effective sensitizing agent, but Sir J. Herschel had already attempted to apply it to that purpose, and Read had actually succeeded in doing so. In 1840, Sir J. Herschel had found that photographic effects might be produced by means of any chemical agent whose constituents are not firmly combined. And, in 1841, Claudet discovered that certain substances possessed the property of imparting rapidity, that is, of diminishing the time required for exposure to the action of light.

It has been asserted that Watt obtained pictures with both silvered plates and paper; and specimens of photography on these substances, said to have been produced by him, have been exhibited.

Attempts were soon made to obtain substitutes for paper, which is exposed to many and serious defects, particularly when used for the production of negatives. M. Niepce de Saint Victor was very successful in this, as he has since been in other branches of photography. Like his uncle, the colleague of Daguerre, he was in the army before he became an experimentalist. In 1842, being a lieutenant of dragoons in garrison at Montauban, he amused himself with scientific researches. It happened that the government resolved in that year to change the colour which had hitherto characterized the uniform of the regiments of dragoons, for another. But where was Mareschal Soult to find the money required for this alteration? Hearing of Niepce as a young officer who was likely to carry out his plans with the required economy, he sent for him. On arriving in Paris, Niepce showed that a brush dipped in a certain fluid would produce the required transformation. He received five hundred francs for his ingenuity, which saved the government a thousand times as much, and a gracious letter. While in Paris, he was greatly struck by the photographs which met his view on every side, and, coming to the conclusion that there only could he make experiments with full effect, he managed to have himself transferred to the municipal guard of that city, and established his laboratory in the barrack of the Faubourg St. Martin. Here he made discoveries which have inscribed his name in the annals of photography. In the conflagration of the barrack, after the flight of Louis Philippe, all his specimens and apparatus perished, but he was soon more favourably circumstanced than ever. The provisional government made him captain of the Republican Guard, and, afterwards, the Emperor Napoleon appointed him Commandant of the Louvre. In 1847 he presented a memoir to the Academy of Sciences on a means of obtaining pictures on glass. Starch was the first substance he employed as a

coating. He afterwards adopted albumen, which he preferred to gelatine, because less easily soluble in water.

In 1838, Ponton, of Edinburgh, discovered the insolubility produced in bichromate of potash by light. In 1853, Talbot found that organic matter in contact with it became insoluble in the same circumstances. In 1855, Poitevin applied this fact to lithography. In 1859, Asser, of Amsterdam, invented the mode of "transference," founded on the facility with which printer's ink spread on gelatinized paper, may be removed by water; and in the same year, Gibbons discovered a method of producing the picture from a negative directly on the stone.

Many persons claim the merit of suggesting waxed paper, as a very transparent material for negatives. Many, also, are mentioned as having first used collodion, the applicability of which to photography was made known simultaneously in France and England, in 1851. In that year, a report became prevalent that a clergyman of the United States, named Hill, had found out a means of reproducing the natural colours of objects. Incredible sums were realized by the sale of books, which appeared in succession—being paid for by the subscribers in advance, and which, it was promised, would reveal the important secret, but they gave no clue whatever to it. Various efforts were then made to obtain the desired information by energetic means, but without success; and the "Hillotype" sunk at length into oblivion. Nevertheless, the reproduction of colour is not impossible, and "Heliochromy" has already advanced so far as to constitute a recognized though, as yet, little more than a *future* branch of photography.

We are indebted to M. Edmond Bequerel for a knowledge of the fact that a silver plate acquires, by immersion in a solution of chlorine, the property of reproducing the colours of the spectrum. The effect, however, is but transitory; since it vanishes at once under the influence of white, and gradually under that of coloured light. Fixation, therefore, so long the desideratum of photography, is at present the great object of search in heliography. But something has been done already, even in this direction. In 1861, Niepce de Saint Victor announced that, if the problem of fixation was not solved, there was reason to expect its solution. In his laboratory at the Faubourg St. Martin, he made the important discovery that the different colours give rise to absorption of the vapour of iodine, in different degrees. He found also that, when a silver plate is plunged into a solution of chlorine, the strength of which is regulated, any particular colour may be made to appear on the plate. The least possible quantity of chlorine allows the reproduction of yellow; progressively larger quantities, give green, blue, indigo, violet, red, orange—the last, appearing

only in a saturated solution. He observed that certain metallic chlorides, particularly chloride of copper and sesqui-chloride of iron, give coloured images still more readily than a mere solution of chlorine. Portraits artificially but skilfully coloured have been sold as the pure products of heliochromy; no coloured photograph has, however, as yet been produced by it.

Photography has already become of the highest importance, its votaries are scattered in tens of thousands over every part of the world; it has been pressed into the service of every art, science, and manufacture. Nor are its uses confined to the requirements of tranquillity and peace; it has been made a portion of the appliances of war, and on a rather considerable scale, as appears from a paper read before the Photographic Society of London, in December last.* The extent to which it has caused an increase in the consumption of chemical substances may be conceived from the fact that, at Frankfort, during the year 1862, 5400 German pounds of the finest grain silver, worth 163,428 thalers (about £36,000), were devoted to the manufacture of nitrate of silver alone [*Photographisches Archiv.* Sep. 1863].

OZONE AND OZONE TESTS.

BY E. J. LOWE, F.R.A.S., F.G.S., ETC.

Ozone is a subject that has attracted a large amount of interest within the last few years. Schonbein, in making the important discovery of ozone in the atmosphere, added fresh work to all meteorological observers, and their labours have thrown some light on the subject. To those who have no knowledge of this new property of the air, it may be said that, if a piece of paper be dipped into, or coated over, with a solution consisting of starch, iodide of potassium, and distilled water, dried and then exposed to the air, it becomes more or less coloured, according to the amount of ozone present at the time. Dr. Moffatt, who was the first to take up this subject in England, has rendered great service to science, and his tests have been almost universally adopted by English meteorologists for a number of years; and although an extended series of experiments has convinced me that the tests I am now making are purer, and better adapted for a thorough insight into this chemical property of the air, nevertheless our warmest thanks are due to Dr. Moffatt for his valuable labours in this branch of science. Before turning to ozone tests, we will say a few words on ozone itself.

* *Photographic Journal*, Dec. 1863.

Locally it varies considerably, being most abundant near the sea and in high mountainous districts, and least so in cities and large towns. There is more ozone at Silloth, a seaport town in Cumberland, than in any other British station; whilst in Scotland the amount is very great at Braemar, a mountainous town near the Queen's residence at Balmoral. On the other hand, at Manchester and in London very little exists. Then, again, there are periods with much ozone, and periods with scarcely any. An instance of this occurs in the month of January just passed; up to the 19th scarcely any ozone was present, whilst from the 19th to the end of the month the amount was considerable.

No doubt, circumstances act for or against the development of ozone, at one time augmenting the amount, and at another diminishing it. Chemical action increases with an increase of heat, and diminishes with an increase of cold; to this cause is probably owing the absence, more or less, of ozone in frosty weather. Moisture to a certain extent is favourable to chemical action, yet an excess of moisture acts in the opposite direction; there is less ozone with a very dry air, and still less with one completely saturated with moisture. It must be borne in mind that we frequently have the air saturated with water, whilst the atmosphere never approaches perfect dryness; on the driest days a considerable amount of water is present in the air. There is a striking difference in different directions of the wind, for there is least ozone with a N.E. wind, and most with one between S.W. and S.S.W.; the latter contains air much charged with moisture, whilst the former is more or less dry; then, again, as a rule, the S.W. wind is brisk, whilst the N.E. wind is sluggish. An increase in the pressure of the wind, which is synonymous to an increase in the velocity of the air, is attended with an increase in ozone, as registered on the test-slip; yet it does not follow that there is an actual increase, because if the same amount is present to-day as yesterday, and if to-day the velocity of the air is five times greater than yesterday, it will be apparent that five times the amount of air charged with ozone must pass over the test-slip, and this will, no doubt, increase the colour of the test.

It seems somewhat singular, that the lower the barometer falls the more does ozone develop itself; that at a pressure of 29 inches there is considerably more ozone than with one at 30 inches. Let us consider what this difference means: when the barometer is at 30 inches, the air is capable of balancing a column of mercury 30 inches in length, whilst when it is only 29 it can only balance one of 29 inches; with the barometer at 29 inches, a cubic foot of air at a temperature of 10° weighs about 573 grains; at 30° about 549 grains; at 50° about 526

grains; at 70° about 504 grains, and at 90° about 482 grains; with the barometer at 30 inches, below the freezing point, it will be about 20 grains heavier; at a temperature of 50°, 18 grains heavier; and at 90°, 16½ grains heavier. Supposing the atmosphere to be completely saturated with moisture, the weight of vapour in a cubic foot of air, at a temperature of 30°, will be 2 grains; at 50°, 4 grains; at 70°, 8 grains; and at 90°, nearly 15 grains. The amount of vapour differs, according to the difference between the wet and dry bulb thermometer; taking the greatest difference, or driest point at each temperature, the weight of vapour at 30° will be 1 grain; at 50°, 2 grains; at 70°, 4 grains; and at 90°, 6 grains; so that at least six times as much moisture exists in the hottest days as in the coldest; we, however, feel the air to be drier, because at a temperature of 30° only 1 grain extra is required for perfect saturation, whilst at 90° it would require 8 or 10 grains extra.

If the air were completely saturated with moisture, the whole amount of water in a vertical column of the atmosphere would be 2½ inches at a temperature of 30°, and 19½ inches at a temperature of 90°; but if the air were unusually dry, the amount would be 1½ inches at 30°, and 10 inches at 90°. This little analysis of the atmosphere will give an insight into the subject; yet it does not afford us a clue to the reason why more ozone exists with the barometer low, unless we consider that, as wind accompanies a low state of the barometer, it is to be attributed to this cause alone.

From what has now been said, it becomes evident that certain corrections will become necessary before the actual amount of ozone can be determined.

We next come to the test used in these investigations, which was the subject of much discussion at the Cambridge meeting of the British Association. Great difficulty has always been experienced in producing tests that should all register alike; if we expose those of Schonbein and Moffatt's together, we do not get the same result, and even tests made by the same persons at two different times will also not read alike, and my investigations were with the view of finding out the cause of this. Commencing at the very beginning of their manufacture, it at once occurred to me that the starch of commerce of which they were made could not be sufficiently pure for such delicate experiments; in their manufacture, lime, sulphuric acid, and chlorine are used—substances which will themselves colour the tests without the aid of ozone. Place under a bell-glass a small cup of chloride of lime, and under another a piece of limestone, on which sulphuric acid has been poured, and under these glasses suspend an ozone test; a few minutes will suffice to demonstrate this. The ordinary iodide of potassium is impure; and

it is by no means easy to procure a proper chemically-pure paper; that which was used by Dr. Moffat (ordinary writing paper) is very impure.

Requiring pure starch, and uncertain what starch would be the best, I set about manufacturing it myself, without the usual aid of chemicals. The substances used were wheat, rice, sago, potato, arrowroot, crocus, snowdrop, tulip, narcissus, arum, etc.; these were reduced to powder, steeped in distilled water, which was constantly changed, until the pure starch alone remained, the result being perfectly satisfactory; a starch was produced from all the above substances, which, for whiteness and purity, could not be surpassed. Chemically-pure iodide of potassium was procured, through Mr. James Glaisher, from Mr. Squire, of Oxford Street, made expressly for these experiments; one portion prepared with water, and another crystallized several times from alcohol.

At the recommendation of Dr. R. D. Thomson, 15 grains of prepared chalk were added to every ounce of air-dried starch, to prevent sourness. This, unfortunately, has the effect of diminishing the sensitiveness of the tests, yet appears requisite for uniformity of effect, as the intensity of action depends much upon the amount of water contained in the starch. The following experiment will make this apparent:—A test made with air-dried starch showed the presence of ozone with 5 minutes' exposure. Further drying by fire-heat for one minute retarded it to 7 minutes; 10 minutes' drying by fire-heat retarded it to 13 minutes; 30 minutes' drying by fire-heat caused the presence of ozone not to be seen, with less than 20 minutes' exposure; whilst the same powders merely air-dried, yet having the addition of 15 grains of chalk to each ounce of starch, also occupied a 20 minutes' exposure before ozone could be detected.

With regard to the material used for tests, either *chemically-pure* calico or *chemically-pure* paper answered well; but ordinary writing-paper, or any other impure material, coloured in course of time. Some papers would be stained and useless in twelve hours.

We have said that the method of ascertaining the amount of ozone was by means of test-slips; but, in order to ascertain if something more sensitive might not be substituted, I tried as a first experiment a mixture of 10 parts of starch to 1 of iodide of potassium, carefully mixed together as a *dry powder test*; a small portion of this mixture was placed in a pill-box in the open air, and in the short space of ten minutes' exposure it was shown that *dry powder tests* were an undoubted success, colouring well, and much more rapidly than the test-slips.

The next determination was with regard to a proper formula—Schonbein using one of 10 parts starch to 1 of iodide of

potassium, and Moffat another of $2\frac{1}{2}$ starch to 1 of iodide of potassium. No satisfactory reason was given why Moffat used so different a formula to Schonbein. It occurred to me that, if a number of different strengths were prepared from equal portions of each up to 30 parts of starch to 1 of iodide of potassium, that if one of these strengths was coloured sooner than another this should be the proper formula to adopt.

Having mixed a number of powders of different strengths with wheat starch, and exposed them to the air, a very short exposure showed that 1 part of iodide of potassium to 5 of starch was soonest coloured, and gradually darkened beyond all other strengths; and many repetitions of these experiments always gave the same results. The degree of darkness diminished in either direction when other strengths were used—thus, even 1 of iodide of potassium to $4\frac{1}{2}$ of starch, or 1 to $5\frac{1}{2}$, were neither so dark as with a strength of 1 to 5. It became, therefore, evident that these were the proper proportions to be used with wheat starch; or, at all events, with perfectly pure wheat starch, such as I had experimented upon. On repeating these experiments with potato starch, the proportion which coloured soonest was 1 to $2\frac{1}{2}$ of starch, showing that the formula must be based on actual experiment, and that a special formula is requisite for each vegetable starch. It next became a question as to what starch would be most sensitive; and, to arrive at this, experiments were tried with tulips, crocus, narcissus, snowdrop, arum, etc.; and very fine starch was manufactured from the bulbs of all these plants. Investigations, which I am at the present moment engaged in, will soon show what starch will be the best to adopt.

Further experiments were tried, with the view of determining the effect of various acids, etc., on the ozone tests; and in order to ascertain this conclusively, two small cups were placed under a bell-glass—one containing an acid or other substance, and the other an ozone test powder. From these it was found that hydrochloric acid, nitric acid, nitrous acid, chloride of lime, phosphorus, iodine in scales, iodine dissolved in alcohol, carbonate of lime, and carbonate of iron, on which an acid had been poured, all coloured the tests, and some most rapidly. These experiments also showed that a new method of investigating ozone had become apparent; it was found that a different colour was imparted to the powder, and that the powder penetrated more or less deeply, according to what coloured the test; differences of effect took place, by which the different materials used might be recognized. Iodine, although it coloured to a *brown-black*, was merely a surface colouring, below which the powder was colourless; Phosphorus, a *bluish-black*, on the surface only; Chloride of Lime, *deep brown*, on the surface only,

below which the powder was slightly yellow; HYDROCHLORIC ACID, *grey pink*, on the surface only, the powder beneath orange; NITRIC ACID, *dark red-brown*, extending slightly into the powder, beneath colourless; CARBONATE OF IRON WITH GLACIAL ACETIC ACID, *yellowish-brown*, penetrating to the thickness of cardboard, below which buff; LIMESTONE WITH SULPHURIC ACID, *pale-brown* to the thickness of cardboard, beneath which slightly coloured; CARBONATE OF IRON WITH SULPHURIC ACID, *black* to the depth of a quarter of an inch; NITROUS ACID, *dark brown* more than an eighth of an inch deep, beneath which yellowish-brown. These differences are so striking that important results must follow their investigation.

The action of ozone on the powders is somewhat analogous to that produced by nitric acid; yet dilute nitric acid, when increased to ten times the strength which the French philosophers declare is the proportion present in the air, is far too weak to produce any colour on the tests.

There are marked advantages in the *powder tests* over the ordinary test-slips; they are more sensitive and more rapidly acted upon, and they retain their maximum colour, not fading afterwards, as is the case with the test-slips of Schonbein and Moffat. For one of Mr. Glaisher's scientific balloon ascents I prepared some doubly-sensitive powder tests, which showed the presence of ozone in the short space of four minutes after leaving the earth, whilst the test-slips remained for nearly an hour uncoloured.

A careful consideration of several thousand experiments inclines me to the belief that ozone is always present in the air, as on no occasion has my sensitive dry powder test failed to show traces of it, even at a time when the ordinary test-slips have remained for days uncoloured.

Mr. Burder, of Clifton, near Bristol, has drawn attention to the fact that ozone is never present in a room even with the window open. Last autumn I carried on a series of experiments, from which the same fact was arrived at, so far as regards the ordinary test-slips, and this is because the air is more or less stagnant in doors; were these test-slips to be exposed out of doors whilst the air was calm or stagnant, they would not exhibit any signs of ozone. However, my delicate powder tests became faintly coloured not only with the window open, but in an apartment with a closed window. The current produced by a fire conveyed sufficient ozonized air across the test-powder to show the presence of a small quantity of ozone.

On the completion of a second series of experiments, we will return to the subject.

PORTABLE EQUATOREALS.

BY WILLIAM C. BURDER, F.R.A.S.

It is perhaps more important in regard to astronomical instruments than to most others, that there should be in the minds of those who use them distinct ideas of the objects in view in their construction, and their capabilities and limits as to usefulness.

Without such ideas, amateurs are very apt to make a false start, and to find themselves, consequently, obliged to return to their starting point, disappointed, both with their own work, and with the instruments which they have been attempting to use. Perhaps no instrument stands in need of this prefatory remark more than the Equatoreal, a name which probably conveys to the mind of the beginner an impression, in most cases, of a very different instrument from the one which his subsequent experience discovers it to be. To the professional astronomer who possesses a good steady working equatoreal, and who has no leisure for astronomical recreation, as such, it is easy to imagine that the term "portable," applied to equatoreals is by no means suggestive of pleasing associations. The very great difficulty experienced in constructing the larger sort of instruments, so as to combine great steadiness with a perfectly easy motion—qualities absolutely essential to their good performance—and the variety of causes which have a tendency to introduce sources of error in the working of the equatoreal, are reasons why the thoughts of the professional astronomer in reference to these instruments are likely to be very different from those of the amateur whose aim is astronomical amusement and instruction, rather than the advancement of the science, even in a feeble manner. The possessor of the portable equatoreal must consider himself happy if he finds his instrument a means of using an ordinary telescope to much greater advantage than would be possible without its aid. That he may do this there is not the slightest doubt. Indeed it is not too much to say that a simple equatoreal mounting for an ordinary pocket telescope multiplies its usefulness fourfold, or perhaps much more. We may take it for granted that the readers of the many interesting astronomical papers which have appeared in the Intellectual Observer, do not most of them require that many remarks should be made on the general principles of equatoreals; still, as there are always new readers to every article, the former class will, it is hoped, forgive the writer if he goes somewhat over old ground in a few preliminary remarks, in order to make the description more complete to the latter class.

The equatoreal, then, is a telescope mounted in such a manner as to enable the observer to follow the diurnal motion of a celestial object by one uniform movement round an axis. This axis produced would necessarily touch, so to speak, the heavens at the pole, the altitude of which equals the latitude of the place. Any method by which the observer can readily place this axis in such a position as to point to the pole in the heavens will place his instrument in adjustment and ready therefore for use; but in practice this is not so easy a matter as it might at first sight appear to be. In order that the telescope shall be correctly pointed to an object, the declination or north polar distance of the object must be known, and the index set to the proper division. The movement on the axis referred to will then be sufficient to ensure the telescope's following that object by the axial motion already referred to without again touching the motion for declination. A little consideration will show such matters very clearly. This diurnal axial motion is performed by a clock in the larger equatoreals, so that the declination circle being once set, the object remains in the field of view as long as it is above the horizon, without any further help from the observer. Of course this is on the assumption that the declination of the object in question does not itself change during the interval. The clockwork movement is a luxury which the possessor of the portable equatoreal must not hope to realize. He must be satisfied to move his instrument by hand, but when once he has carefully set the declination-circle he will find the following of the object by the one motion only, even by hand, a very great advantage compared with the "fishing" kind of use of the telescope which is necessary in other cases.

Several years ago the writer amused himself by trying to find out the simplest kind of construction capable of converting an ordinary pocket telescope into a portable equatoreal. The result is described in *Recreative Science.* The two movements used in the construction of that very useful little thing, a brass "clip," with an iron screw at its base to enable the observer to secure his telescope to a post, tree, window-sash, etc., with perfect steadiness, being the same in principle as those of the large equatoreals, suggested the using of such clip equatoreally. To do this it was necessary to graduate the two little circles where the motion is visible. There was some difficulty in this, but the labour was well bestowed, and the result was perfectly satisfactory. Thirteen years' occasional use of the instrument has quite proved this. It never fails in enabling the observer to find an object in the field of view by day or night. But it is in the daytime when the little instrument desires to display its powers most, when an object is found by it which could not

be found by the fishing process, and found at once by the setting of the circles, without touching the eye-piece end of the telescope.

Perhaps it may not be uninteresting to give an account of the performance of the writer's portable instrument on one particular occasion, when all circumstances combined to display it to the best advantage. The writer was desirous of proving the capabilities of the Portable Equatoreal in the presence of an astronomical authoress, well-known to the readers of the INTELLECTUAL OBSERVER—one whose works prove her to be peculiarly well qualified to appreciate any instrument calculated to illustrate the *recreative* character of the science. An opportunity occurring for showing the working of the instrument to several persons, among whom was the Hon. Mrs. Ward, one magnificent morning in July, 1859, the telescope and clip were placed in a small carpet bag, and a ticket was taken, *viâ* Midland Railway, to a delightful rural spot in Gloucestershire. The place being quite new to the writer, and the latitude and longitude differing from what had been adopted for the adjustment of the instrument at Clifton, so as entirely to throw out of the field of view any object sought without taking this difference into account—and there being no land mark previously determined for a south point, etc., made the occasion a good test of the capabilities of the instrument, and one which all present appreciated. The first step was to obtain a south mark. For this purpose, the sun, a watch, and the hour-circle of the clip placed horizontally, furnished the necessary materials. Making the requisite calculation for longitude, and taking an azimuth from the sun—previously calculated for several intervals from noon in case of need—I obtained a mark. A stick placed in the ground answered the purpose. The equatoreal was placed on a table on the lawn. One word by way of explanation of the azimuth, for the beginner. The time being known, the distance in degrees from the south, of a point in the horizon which is cut by a plumb-line held so as to bisect the sun, becomes known, and thus the south point is obtained by calculation. It is to be remembered that all this is for placing the instrument in a state of adjustment so that the axis may point to the pole as previously stated.

On the occasion referred to, the problem given was to find Venus in broad daylight, by means of the graduated little circles before mentioned. I now look at my watch, and having previously calculated how many degrees from her meridian passage Venus will be by the time that I have completed my adjustments, I set the telescope to the proper declination and distance from south corresponding to such interval from her meridian passage, and predict that at such and such a minute she

will be in the field of view. On this occasion I might have been forgiven if a blunder had taken place, as it is much more difficult to avoid such awkward result when any effort is made to sustain a conversation and calculate at the same time; but luck favoured me, and having set the instrument, I had the pleasure of requesting that the authoress to whom I have referred should look through the telescope at once before I had done so, so as to make the performance of the equatoreal the more satisfactory. And there was the planet sure enough, and, as luck would have it, very near the centre of the field. I say luck as to this, because the instrument does not profess to do so much, although I may say that if care be taken in the adjustments, the object is always nearer to the centre than to the edges of the field. I can assure the reader that on this fine summer's day so successful an exhibition of the instrument under such agreeable circumstances was a real treat to me; and I have no doubt that any enthusiastic amateur who may happen to read this account will be able to imagine the satisfaction I felt. As a still more severe test of the instrument, but one which I did not quite like to risk *first*, I afterwards found Arcturus in the same manner. As the power used was only 20, and the diameter of the object-glass 1¼ inch only, there was a risk of not seeing *stars*, which, of course, even first magnitudes, are extremely faint in broad daylight. But if Venus be not found, it may always be taken for granted that she is not in the field of view, unless, indeed she is very near the sun, or the sky is at all hazy. Under a clear atmosphere Jupiter can easily be seen also in broad daylight, and Saturn when the daylight has only very slightly declined.

I have probably said enough to show that the portable equatoreal is an instrument of a most recreative kind. But it is more. It is really very *useful*. By means of it, for iinstance, a comet whose R A. and N. P. D. are known may be found very much earlier than with an ordinary telescope. The instrument being set to a certain position, a comet may be seen in strong twilight, when the chances would be greatly against finding it by an instrument not graduated. At first view, it may strike some readers as a very rough kind of thing not to have circles graduated so as to be certain to a quarter of a degree; but two considerations will enable the reader to view this in a very different light. The first is, that the circles graduated are less than one inch in diameter and divided by hand (of course this would be better done by machine); and the second is, that the resultant error may be the *accumulation* of several errors in adjusting the instrument, all which adjustments are necessarily rough. I will here remark, in answer

to objections on the ground of the smallness of the circles, that any increase in the diameter of these circles destroys to that extent the compactness and portability of the "clip"; in fact, the great end in view, that of making the portable little piece of mechanism which goes by that name, answer many really useful purposes, besides those originally contemplated in its construction—at the same time without interfering with its own original capabilities—would not be attained if the diameter of the circles were materially increased.

I will finish my description by noticing another advantage of the instrument—that of an unattached *day-finder* for a larger instrument. When once the object, such as Venus or Jupiter, is in the field of the small equatoreal, a large instrument may be directed to such object with great ease. My plan is as follows:—Make the outside edges of the two telescopes sensibly parallel, by eye, and, by means of an instrument consisting of a level and graduated arc, make the inclination of both to the horizon the same. After a few seconds employed in doing this, the object will be found in the larger instrument. Some years ago I found this plan most convenient in directing a large reflector, 12 inches diameter, to Venus, Jupiter, and Saturn, when it would have been hopeless to attempt to find them by ordinary means.*

ON THE ANCIENT LAKE HABITATIONS OF SWITZERLAND.

BY HENRY WOODWARD, F.Z.S.

(*With a Tinted Plate.*)

THE evidence of the high antiquity of man has long occupied the earnest attention of scientific men, and has of late attracted the notice of educated people generally.

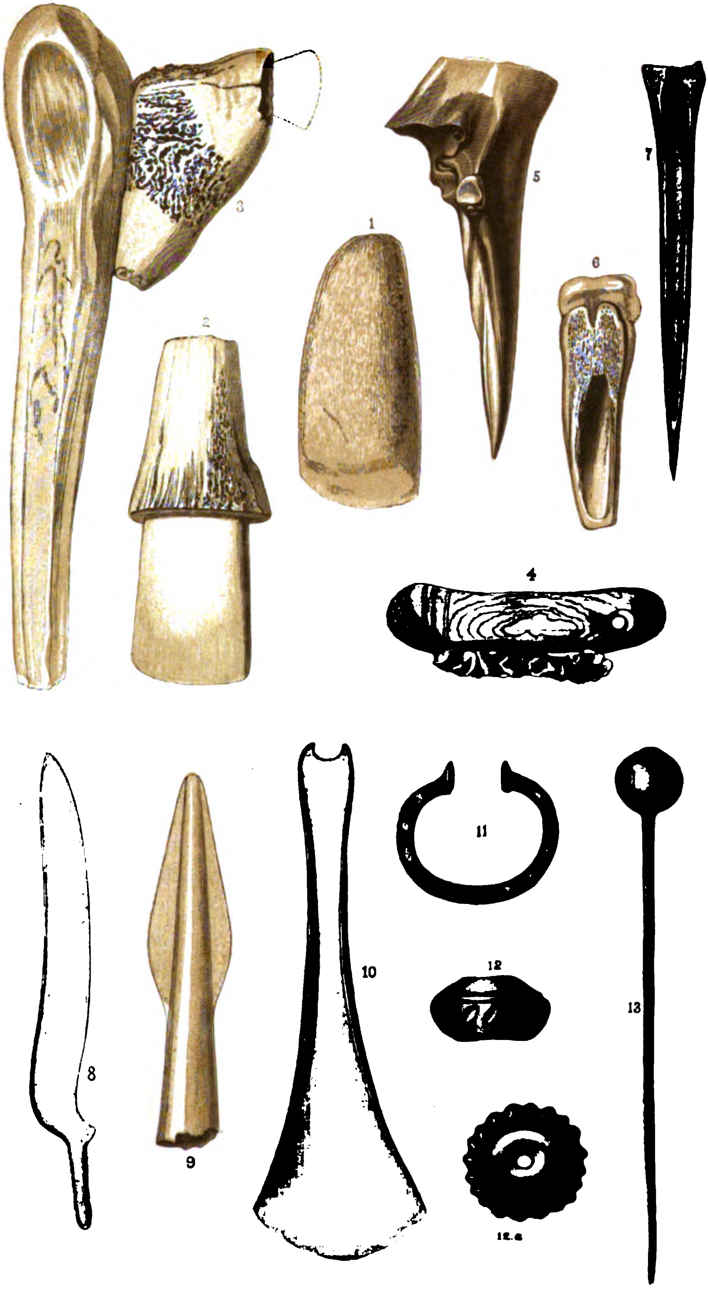
The reason for this will be found in the number and importance of the discoveries made of late years in localities as widely separated as Ireland and Switzerland, France and Denmark, England and Belgium.

These discoveries include:—

I. Oval and spear-shaped flint implements of a rude but uniform type, occurring in "drift-gravels" in the valleys of the Seine and Somme, in France; the Ouse and the Waveney, in England, etc., etc., associated with the remains of extinct species of elephants and other pachyderms, etc.

II. Human remains and implements, with horns, bones, and

* Horne and Thornthwaite's "Star Finder" is an elegant instrument for this purpose.—ED.



IMPLEMENTS AND ORNAMENTS

of the Bronze and Stone Periods, from the Swiss Lake Dwellings.
One-third nat size. Drawn from Specimens in the British Museum.
(except No. 4, which is after M. Troyon's figure.)

teeth of extinct animals, in caverns near Torquay, Devonshire; Liégé, Belgium; and many localities in France and Germany.

III. Shell-mounds, or "kitchen-refuse heaps" (Kjokken-mŏdding), containing flint implements and other reliques, and bones of various animals, birds, and fish, found almost everywhere along the Danish coast.

IV. Works of art, of three distinct epochs, in the Danish peat-mosses.

V. Artificial islands (*Crannoges*), with abundance of animal remains, and works of art from the Irish lakes and peat bogs.

VI. "Pile-works" (*Pfahlbauten*) of the Swiss lakes.

The last-mentioned of these discoveries is so interesting, that I purpose to give a brief *résumé* of the facts and results for the information of those who may not have read the various details, published elsewhere.*

The objects figured in the engraving† are (with one exception) exhibited in the British room of the British Museum, and are selected from the small but choice collection obtained in part through the kind exertions of the Honourable Admiral Harris, H.B.M. Minister at Berne, and in part presented by Colonel Schwab, of Bienne.

I shall refer to them in the course of my narrative, and give a list of objects at the end. The collection represents no fewer than twelve localities, and seven different lakes.

The Swiss fishermen and boatmen had frequently observed, during calm weather, what appeared to them to be the clustering collections of erect stems of trees, from ten to twenty feet beneath the surface, in the clear waters of the lakes, which were supposed to be remains of submerged forests. They

* The writer begs to express his thanks to his friend, Mr. John Evans, F.S.A., F.G.S., etc., and to his colleague, Mr. A. W. Franks, F.S.A., etc., of the Department of Antiquities, who have kindly assisted him with valuable information suggestions, and advice. Those who desire a more full account are referred to the following works, to which the writer begs to acknowledge himself indebted for much information and most of his facts:—

"The Ulster Journal of Archæology," 1859, Belfast, vol. vii., No. 27, pp. 179—194. [A translation of a paper by M. Fred. Troyon, on Swiss Lake Dwellings, and an Account of Irish Crannoges.] "Archæologia," London, 1860, vol. xxxviii., p. 177: W. M. Wylie, M.A., on Lake Dwellings of the Early Periods. "Natural History Review," 1862, vol. ii.: J. Lubbock on the Ancient Swiss Lake Dwellings, etc. Lyell, "Antiquity of Man," London, Nov. 1863. Troyon, Fred., "Habitations Lacustres," Lausanne, 1860, 8vo. Keller, Dr. Fred. "Die Pfahlbauten," in Mittheilungen Der Antiq. Gesellschaft, Zurich, Bd. xii., 1858, and B. xiii., 1860. Rütimeyer, Dr. L. "Untersuchung der Thierreste aus den Pfahlbauten der Schweiz," in ditto, Bd. xiii., 1860. Keller, Dr. F., "Keltischen Pfahlbauten in den Schweizerseen," Zurich, 1854. Herodotus, lib. v., cap. 16. "Illustrated Catalogue of the Museum of Royal Irish Academy, Dublin," by Mr. W. R. Wilde, M.R.I.A., on "Crannoges." M. Morlot, "Leçon d'Ouverture d'um cours sur la haute Antiquité fait a l'Académie de Lausanne."

† The original drawing was most carefully prepared from the specimens, by my friend, Mr. J. Dinkel, of Oakley Square.

were noticed to run in a parallel direction with the shore, and about 100 yards distant from it; but no investigation of their true nature was made until 1853.

In consequence of the dryness of the winter of 1853-4, the Swiss lakes and rivers sank lower than had ever been previously known; and the inhabitants of Meilen, on the Lake of Zurich, availed themselves of the opportunity to recover a piece of ground from the lake, by raising its level with mud taken from the neighbouring shallows. Whilst excavating, they discovered a number of wooden piles, deeply driven into the bed of the lake, formed of the stems of oaks, beech, birch, and fir trees. The mud among these piles contained a great mass of reliques, consisting of numerous bones of animals, all of which had been cut, broken, or gnawed, and the marrow extracted; hammers, corn-crushers, a great variety of axes and celts, of various kinds of stone, many of which were fitted into hafts of stag's-horn. Flint implements were also numerous, which is the more remarkable, as flint is rarely found in that country. Large slabs of stone, which had been used as hearth-stones, were also noticed. One amber bead was found, which, it is supposed, must have been brought from the shores of the Baltic. One or two hatchets and wedges of jade have also been met with, the material for which, it has been asserted, could only have been obtained from the East. But it seems much more probable that both these substances were occasionally, although very rarely, found in Switzerland or the south of France, rather than (as has been proposed by some archæologists) to suggest that this ancient race trafficked with northern and eastern tribes to obtain axes of jade or ornaments of amber. Pottery occurred in abundance, but always in a very fragmentary state. It was hand-made, and of a rude and coarse description. Masses of charred wood, apparently parts of the platform of the building, were abundant. Indeed, it was evident that not only this settlement, but the great majority of those subsequently found, perished by fire. Since the first discovery of pile-works at Meilen, the Swiss archæologists have displayed untiring industry in exploring fresh localities, and not only in lakes Constance, Geneva, Neuchâtel, Bienne,* Zurich, Morat, Sempach, but also in the smaller lakes of Inkwijl, Pfeffikon, Moosseedorf, and Luissel, similar lake-dwellings have been discovered.

The earliest pile-works, those belonging to the Stone age, present a very rude appearance, the stakes having been sharpened by stone hatchets, assisted by fire. Fire was, no doubt,

* Eleven settlements have been found on the Lake of Bienne, twenty-six on the Lakeof Neuchâtel, twenty-four on the Lake of Geneva, and sixteen on the Lake of Constance.

also used to assist in cutting down the trees in the first instance, and the timber has all been split by means of wedges.

After the necessary rows of piles had been driven, these were strengthened by cross-beams, which supported the wooden platform upon which the huts were constructed. These cabins were mostly circular in form. A singular evidence of this is derived from the discovery of curved pieces of clay, with which the interior had been plastered.

Their preservation is due to the hardening action of the fires within the hut, and also to the ultimate destruction of the settlement by a conflagration. These pieces of burnt clay also bear the impression of interlaced twigs upon their outer surface, thus indicating that the walls were constructed of "wattle" lined with clay.

Portions, apparently, of the thatched roofs are also not uncommon. In Prof. Keller's restorations both round and square huts are represented, similar forms of cabins being in use among the papoos of New Guinea at the present day.*

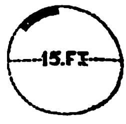
Some of these pile-works were of very considerable extent. For example, the settlement at Morges, on the Lake of Geneva, was 1200 feet long and 150 broad, thus giving a surface of 180,000 square feet. At Wangen alone, on the Lake of Constance, M. Lohle has estimated that 40,000 piles were employed, probably representing the labours of several generations. M. Troyon and others have made several calculations, with a view to ascertain the probable population of these villages. Thus estimating the cabins at fifteen feet in diameter,† and allowing half the area of the platform for gangways between the dwellings, it would give for Morges 311 cabins, which, at four persons for each cabin, would give a population for the settlement of 1244: whilst for the settlements upon the Lake of Neuchâtel it would give a population of about 5000.

These lake dwellings are most admirably separated chronologically by the remains of works of art included in the mud around the pile-works.

The earliest undoubtedly belong to the Stone age (as it has been named), when metals of any kind were wholly unknown, all the weapons found being made either of stone or of the bones and horns of animals. To this epoch belong Wauwyl and Robenhausen, on Lake Pfeffikon, Wangen, on Lake Constance, and the settlement of Moosseedorf.

* Dumont d'Urville, "Voyage de l'Astrolabe." Paris, 1833. Tome IV., p. 607.

† Here again the pieces of burnt clay have done good service, for the smallest segment, if only sufficient to indicate the curve, will give the size of the circle with certainty.



The next series represent the age of Bronze. Here ornaments and weapons, often of high artistic merit, are found, and the other remains indicate the knowledge of useful arts, as spinning, and the manufacture of a higher class of probably wheel-turned pottery. This era is represented by the settlements of Meilen, Bienne, Concise,* and many others. Lastly, at Auvernier, in the Lake of Neuchâtel, and at the Steinberg, in the Lake of Bienne, a few weapons of iron have even been met with.

The distance from the shore at which the piles were driven appears to have been regulated by the nature of the bottom of the lake and the depth of the water. Some few could evidently have been reached only by a boat; but most of them appear to have been connected with the land by means of a narrow gangway supported on piles, a portion at least of which could be readily removed, so as to insure security from the attacks of bears or wolves during the night, or as a means of defending themselves against the hostile raids of neighbouring and more powerful races.

Many canoes have been discovered, associated with the Swiss pile-works, each made of a single tree, and measuring forty to fifty feet in length, and three to four feet in width, the interior hollowed out by stone hatchets, aided by fires. Similar canoes are still used, both upon the rivers of Western Africa and North and South America; and one of my German friends tells me he has frequently crossed both lakes and rivers in Bavaria in such a boat, called an *einbäum*. Early British and Irish canoes were likewise of the same pattern, according to Professor Wm. King, and were used in the latter country so lately as two centuries ago.

Herodotus (lib. v., cap. 16) gives an account of a race called Paeonians, inhabiting pile-dwellings (B.C. 520) in Lake Prasias, in Thrace (now part of modern Roumelia).

Each cabin had a trap-door opening on to the lake, in which fish was so abundant, that it was only necessary to lower a basket by a cord into the water, and haul it up again, and it was found to be filled with fish. When their country was invaded by the Persians, they retired to their impregnable lake habitations with their horses and cattle, subsisting upon fish, and so defied the invader. That horses would eat fish at all, might at first seem incredible; but my late colleague, Mr. Adam White (of the Zoological Department), has recorded, in his *Natural History of Animals* (p. 28), that "both cows and ponies in Shetland readily eat fish-heads in winter!" so that Herodotus was probably correct in his statement.

They made the first platform at the public expense; but

* Meilen, on Lake Zurich, and Concise, on the Lake of Neuchâtel, appear to have been inhabited in both the Stone and Bronze periods.

subsequently, at every marriage (and polygamy was customary), the bridegroom was required to add three piles to the structure.

These habitations, reared upon the bosom of the lake with so much patient industry, unaided by any of those modern inventions which make labour light, were not only intended for places of safe retreat during hostile times, but were also used by each community as their constant place of abode, and all the relics exhumed tell of regular every-day life and permanent occupation.

From the position of these lacustrine dwellings, we should have predicted that they were inhabited by a race of fishermen. The account given by Herodotus of the Paeonians, and the discovery of fish-hooks and pieces of nets, and abundance of fish bones beneath the pile-works, fully confirms this opinion. But the ancient Helvetii were by no means dependent upon the waters alone for their daily food; they hunted and shot the smaller game with bows and arrows, and probably took the larger in pitfalls, as the Zulu Kaffirs do at the present day. In these pursuits they were, from the earliest times, accompanied by man's first and most faithful friend, the dog.

The bones of no fewer than thirty-two animals (most of which were used as food) have been discovered in the various pile-works of the Swiss lakes, and determined by Prof. Rütimeyer.* That able zoologist has also recorded the occurrence of the bones of eighteen species of birds, eight fishes, and two reptiles (these last are the edible frog and the freshwater tortoise; the latter now quite extinct in Switzerland). But, as I have already stated, the earliest of these Swiss settlements indicates a later Stone period than that of the valley of the Somme. No trace of the elephant, rhinoceros, hippopotamus, hyæna, cave bear, or lion (all of which appear to have co-existed with the makers of the flint implements of the earliest Stone period) have been found here; but the urus and bison, the elk and the red-deer, were no mean cattle; and for carnivora, they had to contend with the brown bear, the wolf, the fox, and half-a-dozen smaller denizens of the forest; whilst the fierce wild boar, and the scarcely less formidable marsh boar, also abounded in the woods and lowlands. These animals not only supplied them with food, but their bones and teeth were afterwards converted into weapons and ornaments of various kinds; the horns of the deer serving as hafts for stone implements, and the bones for pins, augers, chisels, and gouges (see plate and description); whilst their skins were doubtless used as articles of dress, etc. Nor was agriculture entirely unknown. Of this we find most conclusive evidence in the carbonized remains of wheat and

* Of these, eight appear to have been domesticated, viz., the dog, pig, horse, ass, goat, sheep, and two species of oxen.

barley, several bushels of the former cereal having been found at Wangen, the grains adhering together in large masses. Ears of barley are also numerous.

Carbonized cakes of unleavened bread, and the round stones used in grinding the corn, have also been found here, and may be seen in the collection. No agricultural implements, except sickles of bronze, have yet been discovered; their other instruments of tillage were doubtless made of wood.

The uncultivated fruit-trees of the forest supplied them abundantly with apples and pears, wild plums, prunes, hazelnuts, and beech-nuts, great abundance of the stones and shells of which, and also seeds of the raspberry and blackberry, are found in the mud around their dwellings. The apples are often found cut in two, and apparently dried for winter use, as is the custom in America at the present day.

Seeds of the water caltrop (*Trapa natans*), now almost extinct in Switzerland, are met with, and are believed to have been used as articles of food. The fibres of flax and hemp have also been found applied to useful purposes, such as cords, netting, and woven fabrics for clothing. (See list of specimens in collection.)

Professor Rütimeyer's examination of the remains of animals obtained from the various settlements, has led to the most interesting conclusions respecting the modes of life of their occupants. For example, in the oldest settlements, those of the Stone age, such as Wanwyl and Moosseedorf, the remains of the stag predominate over the ox, and the goat over the sheep, the wild boar over the domestic hog, the fox over the dog; whilst at Bienne and Meilen, settlements of the Bronze age, the dog predominates over the fox, the domestic hog over the wild boar, the sheep over the goats. Lastly, at the Steinberg (which I have already mentioned as a settlement that lasted down to the introduction of iron), we find numerous bones of the horse, an animal whose remains are *extremely rare* in the earlier settlements. Thus, the Stone age may be said to represent the epoch of the hunter; the Bronze, the pastoral age; whilst the commencement of the Iron age probably witnessed the demolition of the latest pile-works, and was to the Swiss lake-dwellers a time of invasion, conquest, and ultimate destruction by a foreign and more powerful race.

Of their religious superstitions we know little. That they eat foxes and eschewed the hare seems proved by the frequent occurrence of foxes' bones, and the discovery of but one solitary bone of the hare up to the present time.* Col. Schwab

* Such a superstition still prevails among the Laplanders at the present day. The Russians even refuse to eat it! This aversion to the hare is also noticed by Julius Cæsar, in his *Commentaries* (lib. v., cap. xii.), as existing among the ancient Britons.

has discovered a great number of crescents made of earthenware (measuring about one foot across, from horn to horn), compressed at the sides, and sometimes ornamented.

They were probably affixed to the summit of their circular huts. Dr. Keller considers them religious emblems, and to be evidence of moon-worship. The remains of the mistletoe have also been found. This parasitic plant has always been associated with religious rites from the earliest times.

Notwithstanding the profusion of bones of animals in the Swiss pile-works, the occurrence of human remains is extremely rare, which would seem to indicate, that although the conflagrations by which the settlements had been destroyed at various periods had been sudden and overwhelming, yet the inhabitants had always managed to escape with their lives, in boats or otherwise.

Only one skull of the early Stone period, dredged up from Meilen, on the Lake of Zurich, has yet been examined with care. Of this, Prof. His observes, that it clearly resembles in form the skull of the race at present prevailing in Switzerland, which is intermediate between the long-headed and short-headed form.

The duration of time occupied by the epochs just described must naturally be very great, to allow changes so important as those we have indicated gradually to take place. In Denmark each period is marked by a *complete change* in the forest trees of the country. The Scotch fir, the oak, and the beech-tree, have each covered the land, and each in turn has died out, and been replaced by its successor—a process requiring *many tens of centuries* to effect.

The Swiss archæologists and geologists have endeavoured, by a very careful series of calculations, to estimate definitely the periods of time and relative antiquity of the Stone and Bronze ages. The calculations of M. Morlot are based upon an examination of the delta formed by a torrent, known as the Tinière, which falls into the Lake of Geneva, near Villeneuve. This delta was laid open by a railway cutting 1000 feet long and 32 feet deep, and its structure throughout displayed such regularity, as to imply that it had been formed very gradually, and by the uniform action of the same causes.

Three layers of vegetable soil have been exposed, each of which must at one time have formed the surface of this cone-shaped deposit. They are regularly inter-laminated among the gravel, and exactly parallel to one another, as well as to the present curved surface of the cone. The first of these ancient deposits was traced over a surface of 15,000 square feet, at a depth of about four feet. This layer, which was from four to six inches in thickness, belonged to the Roman period, and

contained Roman tiles, and also a coin. The second layer was followed over an area of 25,000 square feet, at a depth of ten feet from the surface, and had a thickness of six inches. It is referred to the Bronze epoch, for in it was found several fragments of unvarnished pottery, and a pair of bronze tweezers. The third layer was traced for 35,000 square feet, at a depth of nineteen feet, and was six to seven inches in thickness. In it were found a human skeleton, with a small, round, and very thick skull, some fragments of very rude pottery, some pieces of charcoal, and some broken bones.

M. Morlot, assuming the Roman period (indicated by the first layer) to represent an antiquity of from sixteen to eighteen centuries, assigns to the second layer, representing the Bronze age, an antiquity of 3800 years, and 6400 years for the third layer of the Stone age.

The second case is afforded by a settlement found buried in peat at the foot of Mount Chamblon, 5500 feet from the present margin of the Lake of Neuchâtel. The Roman City of Eburodunum (Yverdon) was built on a *dune* extending from Jorat to the Thièle. Between this *dune* and the lake, on the site at present occupied by the city of Yverdon, no trace of Roman antiquities has ever been discovered, from which it is argued that the waters of the lake washed the walls of the ancient Castrum Eburodense.

If then 2500 feet have been uncovered in 1500 years, M. Troyon infers that 3300 years must have elapsed since the pile-dwellings at Chamblon were left dry. As this settlement belonged to the Bronze period, the date arrived at agrees very well with that obtained from the delta of the Tinière.

I have only described the construction of the most usual form of Swiss pile work; that in which the platform is fixed to the tops of the piles at a sufficient elevation above the lake to secure the habitations against a sudden rising of the waters. But at Wauwyl, in Lucerne,* the platform consisted of FIVE LAYERS of round timbers securely united together with interlaced branches of trees and the interstices filled with clay. *No fastening of any kind* could be discovered to connect the piles with this massive platform, and it would seem, from a close and careful examination, that the rows of piles only served to retain it in its place, the platform itself floating upon the surface of the water and rising and falling with it.

Again, at the Steinberg, in the Lake of Bienne, an artificial island has been formed by collecting a mass of round

* See Dr. Keller's Memoir, Zurich, 1860 (p. 73), already quoted, for M. Suter's description of this remarkable settlement of the Stone period.

stones,* which are kept together by means of planks of wood, and a circle of piles driven vertically around the mound which is now considerably beneath the present surface of the lake, owing to a supposed rise in the level of the waters. And, lastly, a small island in the little Inkwyl Lake exactly reproduces the *crannoge* which I have mentioned already as so frequently occurring in the lakes of Ireland. Of these *crannoges,* which are sufficient of themselves to form the subject of a separate paper, I will only remark that no fewer than forty-six have been discovered and described, from which remains of the Stone, Bronze, and Iron Age have been obtained. They are frequently referred to in the early annals of the country so far back as the ninth century, and have been used as strongholds and refuges by petty chiefs, rebels, marauders, and freebooters, down to the close of the seventeenth century. They are extremely rich in reliques, but little has yet been done in *systematically* examining and separating their very miscellaneous contents.

I have been informed that the Royal Irish Academy is about to take active measures to harvest this rich field of archæological treasures.

Lake-dwellings have been noticed as having existed in several parts of Asia. In a series of bas-reliefs found at Kouyunjik in the palace of Sennacherib, are represented the conquests of the Assyrians over a tribe who inhabited a marshy region; in one of these slabs† we see represented several small artificial islands (formed apparently by wattling together the branches and twigs of the willows which grew in the marshes, and erecting a platform), in which are sheltered five or six people. Mr. Layard has conjectured that these slabs represent the conquests of the Assyrians over the inhabitants of the lower part of the Euphrates.‡

That lake-dwellings will yet be discovered in England is highly probable. The fens of Cambridge and Lincolnshire and the meres and broads of Norfolk seem ready to reward the explorer. I will give a single instance in point. In draining a mere near Wretham Hall, Thetford, Norfolk, numerous posts of oak-wood, shaped and pointed by human art, were found standing erect, entirely buried in the peat. At a depth of from five to six feet from the surface were found some *very large* antlers of the red deer, several of which, with the skulls attached, had been *sawn off,* just above the brow-antlers.§

* A canoe, laden with stones, was actually found near this spot, having apparently capsized and sunk during the period when the Steinberg was in course of construction. It is one of the largest known, and measures fifty feet in length and three and a half feet in width.

† Engraved in the *Monuments of Nineveh*, second series, pl. 25.

‡ See *Nineveh and Babylon*, 1853, p. 584.

§ See *Quarterly Journal of the Geological Society*, London, 1856, vol. xii. p. 356.

Let me, in conclusion, caution the readers of this journal against the grave error of supposing that, because an era of civilization is well-marked and wide-spread, that, therefore it was contemporaneous throughout the area in which it is known to have prevailed. In proof of this I need only remark that *pile-works* are in fashion now-a-days among the Papoos; that the *einbäum* still floats on many a lake and river; and that, notwithstanding all the efforts of Birmingham and Sheffield, the Fuegian and Andaman Islanders have to-day eaten their dinner with the aid of stone cutlery. So true is it, that "man, placed under analogous circumstances, acts in an analogous manner, irrespective of time and locality."*

Explanation of Plate.—Fig. 1. Stone axe of Serpentine; Concise, Lake of Neuchâtel. 2. Stone axe, fitted into haft of stag's horn; Robenhausen, Lake of Pfeffikon. 3. Haft of stag's horn, with projecting wing, which rests against the handle of wood, in which a square hole has been cut to receive the shaft. [The handle itself is a fac-simile of one found at Concise, Neuchâtel.] 4. Flint saw, formed of a flake of flint fixed into a groove in a wooden handle with a cement of black mastic. [Copied from M. Troyon's *Habitations Lacustres*, Pl. v. f. 11.†] 5. Awl of bone, formed of the *Ulna* of *Cervus Elaphus*; Moosseedorf. 6. Gouge, or chisel, formed of metacarpal bone of deer; Wangen, Constance. 7. Long slender pin, made of metatarsal bone of deer; Moosseedorf. 8. Bronze knife blade; Cortaillod, Lake of Neuchâtel. 9. Spear head of bronze; Nidau Steinberg, Lake of Bienne. 10. Long slender bronze celt; Mielen, Lake of Zurich. 11. Ornamented armlet of bronze; Cortaillod, Lake of Neuchâtel. 12 and 12a. terra-cotta whorl, used in spinning with the distaff; Cortaillod, Lake of Neuchâtel. 13. Bronze pin, ornamented with circles; (probably worn in the hair); Cortaillod, Lake of Neuchâtel.

List of Specimens from the Swiss lake dwellings in the British Antiquities' Room, British Museum:—

Abbreviations.—Moosseedorf (M.), Robenhausen (R.), Wangen (W.), Concise (C.)

VEGETABLE SUBSTANCES.

Seeds of Flax *Linum usitatissimum*,	R.
„ Raspberry, *Rubus idæus*,	W. & M.
„ Blackberry, *R. fruticosus*,	W. & M.
„ Water caltrop, *Trapa natans*,	M.
Wheat (clean), *Triticum sativum*	W. & M.
Six-rowed Barley, in ear, *Hordeum hexastichon*	W.
Two-rowed Barley, in ear, *Hordeum disticum*	W.
Hazel Nuts, *Corylus avellana* . .	M.
Beech Nuts, *Fagus sylvatica* . .	M.
Seeds, etc., of Apple, *Pyrus malus*,	M.
Apples split and dried for winter use	W.
Leaves, etc., of the Mistletoe, *Viscum album*	M.

* F. Troyon, *lib. cit.*

† M. Troyon remarks that such flint saws are used by the Oceanic races in the manufacture of stone implements at the present day.

Specimens of Woods used in the pile-works, White Birch, *Betula alba*, M. Pine, *Pinus*, sp.

FABRICS.

Fragment of Fishing Net made of Hemp? meshes 2 inches square . R.
Fragment of Coarse Fringe of a Dress, R.
„ Coarse Woven Fabric . . . R.
„ Fabric plaited by Hand . . R.
„ Cord made of Willow Bark . M.
„ Burnt Bread, or Cake . . . W.
Piece of Yew Tree, with cuts of a stone axe . . . . M.
Burnt Wood . . . . M.
Portion of the stem of the Flax in the first process of manufacture . R.

FRAGMENTS OF BONES OF THE

Fox, *Canis vulpes* (*ulna*) . . . . M.
Beaver, *Castor fiber* (1 *incisor*, 1 left *femur*) . . . . M.
Wild Boar, *Sus scrofa ferus* (1 right *tibia*) . . . . M.
Marsh Boar, *Sus scrofa palustris* (1 *ulna*, 1 *molar*, 1 *jaw*) . . . . M.
Stag, *Cervus Elaphus* (1 right *femur*, 1 left *humerus*) . . . . . . M.
Roebuck, *Cervus capreolus* (Horn) M.
Goat, *Capra*, sp.? (*tibia*, *Jaw*) . . M.
Urus, *Bos primigenius* . . . . M.
Ox? *Bos taurus* . . . . . . M.
Fragments of various Bones gnawed by dogs?
Prong of a Deer's Horn gnawed by rats.
Various Bones and pieces of Horn cut and marked by flint implements.

BONES, ETC., MADE INTO IMPLEMENTS.

4 Hafts of Stag's Horn, hollowed to receive stone axes . . . . . C.
7 Awls and Pins, made of various bones . . . . M.
17 Chisels and Knives . . . . M.
4 Chisels or Gouges . . . . . W.
1 Haft, with entire Celt *in situ* . R.
1 Haft, with broken Celt *in situ*, St. Aubin.
1 Haft of Stag's Horn . . St. Aubin.
4 Pointed Bone Instruments . . W.
1 Small Needle? . . . . M.

IMPLEMENTS OF STONE, ETC.

10 Stone Celts, or Axe-heads, made of Serpentine . . . . W.
Cast of Axe-head made of Jade? (*original from*) M.
2 Flint Arrow heads . . . W. & M.
5 Flint Saws and Knives . . . M
6 Flint Scrapers . . . . M.
Stone Hammer . . . . W.
2 Round Stone Corn Crushers . . W.
Stone Axe in course of manufacture, with traces of flint saw-marks . W.
Sandstone used in grinding Celts . M.
2 Celts of Serpentine . . . C. & R.
42 Flint Flakes of various forms . M.
18 Flint Knives . . . . M.
8 Flint Chips . . . . M.

ARTICLES OF POTTERY, ETC.

13 Fragments of Coarse Pottery, hand-made . . . . M.
4 Portions of Earthen Pots, used to store corn in . . . . W.
1 Piece of a Vase ornamented with a tree pattern . . . . W.
7 Pieces of rough Pottery . Inkwijl.
2 Earthen Cups (one of which is very elegant in form) . Cortaillod, Lake of Neuchâtel.
Fragment of a Large Vase, Auvernier, Lake of Neuchâtel.
6 Terra-cotta whorls, used in spinning with the distaff . . . Cortaillod.
Portions of the Clay coating the interior of the huts, indurated by fire . W.

WORKS OF ART IN BRONZE.

3 Knife Blades . Cortaillod, Lake of Neuchâtel.
1 Hair Pin Do. do.
2 Celts, with loops Do. do.
9 Rings Do. do.
3 Armlets Do. do.
1 Razor, or Leather Cutter Do. do.
6 Ornamented Pins . . . . Bevais.
1 Long slender Celt, Meilen, L. of Zurich.
1 Chisel . Nidau Steinberg, L. Bienne.

VORACITY OF THE ASPLANCHNA, AND ITS STOMACH CURRENTS.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

THE ordinary text-books do not contain a satisfactory portrait of one of the most interesting rotifers, the *Asplanchna Brightwellii*, and the peculiar arrangement and mobility of the various parts render it almost impossible that a striking likeness should be produced.* In two successive seasons I obtained these creatures from Hampstead Heath, and last November and December found them fairly plentiful in one or two very small ponds at the back of the Castle Tavern. When a fortunate dip is made, and the bottle held up to the light, little exquisitely transparent glassy bags will be seen swimming about, and they will be made noticeable, less by their extremely delicate outline than by a solid-looking patch of coloured matter, generally golden yellow, which stimulates curiosity to find out what they are. As I wish, when opportunity offers, to resume the investigation of these remarkable rotifers, I shall not now append any drawings, or discuss minute details of their organization. Their name designates an astounding peculiarity—the absence of a bowel or anus, which might have been thought indispensable to a creature so highly organized as the asplanchna undoubtedly is.

The *Asplanchna Brightwellii* is almost a twenty-fourth of an inch long. The jaws are called "one-toothed," but the appellation is scarcely correct, as these organs consist of two arms, cleft at their extremities, and having a large toothed projection rather less than half-way down. A carefully-made drawing is before me as I write, and the general impression, when the curved arms (rami and mallei) are placed upright, is not unlike that of a pair of antlers, and they do not seem much better fitted for anything like *chewing* the food that passes through them. Whatever is swallowed goes down a conspicuous gullet, and a very extensible crop, often seen in folds, and abounding in delicate muscular bands. My hope was to find that this was in some way divided, and that there existed a distinct exit-pipe. In this I was unable to succeed, and I can offer no explanation of the riddle which the asplanchna presents. The crop terminates in a stomach of rounded, but irregular form, and when the creature is quiet, the long ovary is folded in a horseshoe round the digestive bag. This ovary

* Since writing the above, Mr. Gosse has allowed me to see his collection of drawings of these creatures, and, as might be expected, they are far superior to any others. The asplanchna requires to be studied in a series of sketches.

may be roughly compared to a long omnibus cushion with rounded ends. It is capable of much motion, and some apparent change of form. I have just mentioned what I may call its normal position; but in a sketch before me, the stomach has ascended quite above it, and below it lies a large, rough, resting egg, nearly ready for expulsion.* Situated a little above the orifice from which the eggs or young are discharged, is the contractile vesicle, or heart, whose motions are easily seen when the other life apparatus is out of the way. There are also complicated tubes, which under favourable circumstances exhibit the so-called "tremulous bodies"—little finger-like projections, on which a high power detects ciliary action that has been supposed to be connected with the animal's respiration.

It is a most voracious creature, and its stomach is often a natural history museum. The teeth do not damage the objects as they go down, so that in one of my specimens I found a small volvox apparently uninjured, and waiting the slow operation of the digestive juice. Mr. Gosse also mentions an instance in which a rotifer that had been passed into the stomach escaped alive. In the stomach of another asplanchna, of which a drawing was made, were no less than seven small rotifers and the jaw of an eighth, one arcella, and a quantity of imperfectly crystallized transparent particles, that acted upon polarized light, and may have been uric acid, together with a mass of matter too much digested to determine its origin. The asplanchna is not only willing to swallow any number of her fellow-creatures, animal or vegetable, that her stomach can possibly hold, but she gulps down objects apparently as inconvenient as if a man should swallow a rolling pin, or the kitchen poker itself. When such an awkward article has been bolted, the stomach is widely distended; the crop does its part to make room for the visitor, by pursuing the same course, and the result is that the entire digestive passage, and stomach bag, together take a triangular form. I saw several instances of this curious process. In one a—relatively—very large piece of the tracheal tube of some insect was stretched like a beam across the stomach, which it pushed quite out of shape. In another case, the creature had swallowed that beautiful little lively vegetable, the *Euglena pyrum*, and the memorandum I made on the occasion was as follows:—"2nd Dec., 1863. Asplanchna B, young one, had swallowed an *Euglena pyrum*, which at one time came partly up into the œsophagus, stretching it so that it was difficult to tell where the stomach began. Then it arranged itself crosswise at the bottom of the stomach, and the œsophagus, crop, and stomach were stretched

* The ordinary eggs are hatched inside. I saw several young ones extruded, exactly resembling the mother.

so as to form one triangular bag. The *Euglena* was elongated into a cylinder with a pointed tail. At another time the ciliary motions of the stomach made it spin round and round about its long axis."

My present object is to call particular attention to the ciliary stomach currents last mentioned, as I have seen them more strikingly displayed in the asplanchna than in any other rotifer. It would seem as if the whole surface of the stomach were lined with cilia in active motion, and the direction of the currents they occasion, depends chiefly upon the gaps that occur in the masses of food. The motions of the creature agitate and constrict the stomach. Thus the food, when reduced to a pulp, is easily divided into separate portions, and the spaces between them form channels, down which the ciliary currents rush. They are easily seen with a good $\frac{1}{4}$ or $\frac{1}{5}$th, but with Smith and Beck's $\frac{1}{20}$th, (and doubtless also with Powell and Lealand's $\frac{1}{25}$th), they are magnificent objects. It was with the former glass I frequently viewed them, and I find on one occasion the following note entered in my microscopic memorandum book :—

"The stomach of the asplanchna exhibits the ciliary motion very finely—the food gets divided into separate masses, and in the inter-spaces, the ciliary currents look like the confluence of ten thousand waterfalls, and often form whirlpools in which small particles are hurled about with great velocity." No drawings can give anything like a picture of such movements; but a diagramatic sketch was made of the most singular, and I find two closely curled whirlpools working away in juxtaposition, and connected with two parallel currents about a seven hundredth of an inch long, both of which were curled inwards at the bottom, and sent up two steady streams, the tendency of which was to cut another channel through the food mass, and to keep its particles bathed incessantly on every side.

Lower powers easily show that these currents exist, but no idea can be formed of their beauty as a spectacle, unless with such an object-glass as the $\frac{1}{20}$th and careful illumination with the achromatic condenser. As thus displayed it was one of the most striking and memorable scenes of the microscope that I have ever witnessed. Some other rotifers may answer the purpose as well as the asplanchna for showing these currents; but I have never met with one equal to it. The tissues are as clear as our finest glass, and the stomach well-situated. Slight compression should be employed, but not enough to hurt the creature whose internal after-dinner arrangements it is intended to survey.

THE FOUNDATIONS OF PHYSICAL SCIENCE.

WE heartily welcome the first volume of the "sixth and completed edition" of Dr. Arnott's *Elements of Physics** because we believe there is no work in any language that can supply its place. Other works of great merit are for the most part† only adapted to those who have already acquired the habits of students, and there is no pleasure in reading them, apart from that attaching to the acquisition of facts in a dry and bald form. Dr. Arnott's famous book is, on the contrary, so admirable for simplicity of statement and elegance of illustration, that no reader, young or old, whose mind is in a condition of reasonable activity, can resist its fascination, or be willing to put it down until it has been carefully read. To those who have everything to learn concerning the physical forces of the universe it will prove a delightful guide, while those who are familiar with the principles it unfolds, will be charmed by the excellence of its method, and by the admirable use it has made of that best of all aids to memory, a natural and comprehensive association of ideas. The writer well remembers the pleasure afforded by an early edition in his schoolboy days, and doubtless many who now occupy important positions in the scientific world will speak of it as one of the few books which contributed to direct their tastes, as well as to lay the foundation of accurate thinking upon the varied problems presented by the external world.

In some respects the most difficult part of Dr. Arnott's labours remains for the second volume, which is promised in October, to conclude the present edition and complete the work. The volume now issued comprehends mechanics, hydrostatics, hydraulics, pneumatics, acoustics, and animal mechanics. "Thoroughly revised," as the author tells us, and "brought up to the present time." The second volume will relate to heat, light, electricity, and magnetism, with astronomy, and popular mathematics. There is a little awkwardness in treating, as this volume does, of boiling water and the steam-engine before explaining the laws of heat; but the matter relating thereto is certainly intelligible to any one who has carefully studied the chapters that precede it.

While generally concurring with the views adopted by Dr. Arnott, we regret that he has placed a particular, and in some respects highly improbable *theory* in the position of his "first fundamental truth." The assertion that "every material mass in nature is divisible into very minute indestructible and *un-*

* *Elements of Physics, or Natural Philosophy, written for General Use*, in Plain or Non-Technical Language, by Neil Arnott, M.D., F.L.S. Sixth and completed edition. Part I. *Longmans.*

† *Philosophy in Sport made Science in Earnest*, is a valuable exception to this rule.

changeable particles," is assuredly not *ascertained* to be true, and there was not the slightest occasion to make a doubtful guess, as in the word we have given in italics, or it may be an erroneous assertion, the foundation of a superstructure built up in accordance with logical rules. So distinctly does Dr. Arnott assert the doubtful doctrines connected with the word *atom*, that he gives as an illustration of the assertion just cited, the case of a piece of metal, bruised, broken, cut, dissolved or *otherwise transformed*, a thousand times, but which still "can always be exhibited again as perfect as at first." Dr. Arnott probably did not intend to convey all that this passage plainly means and implies, and he would surely hesitate to affirm all its unproved assertions, if they were drawn up in due form and presented to his eye. He does not *know* that there are such things, for example, as "indestructible unchangeable particles" of iron. There could only be such particles of simple substances, and who can tell what substance really deserves that name? All compound substances may have an atomic composition—that is to say, they may not be susceptible of division beyond a certain limit without being decomposed; but if so, the smallest possible particle of a compound will consist of two or more still smaller particles of its elements, whatever they may be. The principles of mechanics do not depend upon any of the gratuitous assertions made in Dr. Arnott's so called "first fundamental truth," and it does not coincide with his usually careful and luminous statements concerning either argument or fact.

An accurate knowledge of the elementary principles and facts of physics forms the only possible foundation for the study of more complicated branches of physical science, and it is unfortunately surprising to find how few persons have taken the trouble—or, if Dr. Arnott were the guide, we should say enjoyed the pleasure—of learning these primary truths.

The processes of the human organism develope many forces, but man as a worker creates none; all that he can accomplish is to use his own muscular force, or some other power, so as to accomplish his will. If he boils water and avails himself of the expansive force of steam, he has not made that force. He has merely placed fuel, water, certain masses of metal and other articles so as to be acted upon, in given directions and for a given time, by certain properties of heat. In what are called the mechanical powers (levers, etc.) he does somewhat less, and his action depends upon a few simple principles and facts. This is well expressed in the opening lines of the analysis to the second section of Dr. Arnott's work :—"The bodies or masses composing the universe may be at rest or motion, and to change any present state, force

proportioned to the quantity of the body and to the degree of change is equally required, whether to give motion, to take it away, or to bend it." Every one can see that a body at rest might remain so for ever, if no one, and no thing, exerted the force necessary to make it move; but it is not equally obvious, though equally true, that if once set in motion it would move on for ever, if nothing caused it to stop. Let this truth be felt, and an interesting inquiry must arise concerning what becomes of an arrested force. Science has not yet demonstrated that all forces are correlative; but we are justified in saying that forces are incessantly at work, and that one force only ceases from doing one kind of work by becoming occupied with another kind of work. We recognize a force by what it is doing, or has done, and we give names which designate distinct actions, although they may become erroneous if supposed to designate totally distinct causes. The mechanical force displayed in the swift journey of a cannon-ball to a target, disappears when the object has been struck, and the ball brought to rest; but it has developed great heat, and altered its own internal state, and also that of the target, in addition to the visible effects of crushing and penetration.

Nature is full of practical equations. A small body, moving quickly, equals in force and can counterpoise a larger body moving with proportional slowness. There are innumerable applications of this law; but all are readily comprehensible, provided the manner in which a lever operates is first understood. Ignorance first, and familiarity afterwards, prevents the importance of these simple facts from being perceived; but it is not too much to say, that human existence and civilization would be alike impossible, if small quantities of matter could not be made to balance large quantities of matter, or large quantities made to balance small quantities, by proportioning the quantity of motion imparted to each in a given time. Dr. Arnott puts the question very simply, in explaining that the "apparent paradox of a weight of one pound at the *end* of a beam being rendered through such medium equal in effect to four pounds placed nearer the *centre*, is solved by reference to the nature of inertia and motion. The same amount of force which gives any certain velocity to four pounds is just that required to give four times that velocity to one pound; and owing to the connection of the two weights through the beam, no motion downwards by gravity can occur in the four pounds, without causing a motion upwards just four times as great in the one pound."

The term *inertia* has been so long in use, that there is little chance of getting rid of it; but it tends to give a false idea, which sometimes clings to a student's subsequent thoughts.

A body that does not move because the forces acting upon it are balanced, is not inert in any proper sense of the word. If it be a ball resting on the table, it tends towards the earth's centre by an active gravitation thereto, and it does not go through the table, simply because the cohesion of the wood is greater than the force by which it is pressed downwards. A piece of thin paper held on stretch will support a billiard ball, but a pound weight would go through it. If a body is still, it is so because the forces that act upon it balance each other, and it will move if a fresh quantity of force be added, by which it is overbalanced in any direction. In teaching mechanics, it is advisable that this truth should be borne in mind, and that the pupil should know that the word *inertia* by no means expresses the actual state of the case.

The capacity to be of service in the concerns of practical life depends a good deal upon an acquaintance with the elements of physics, and without that knowledge it is impossible to make sufficient advance in any other science to afford either profit or delight. And yet hundreds of schools still exist, at which boys and girls may pass seven or fourteen years without knowing the difference between a pulley and a screw! For private families the means of pleasurable instruction are supplied by Dr. Arnott's book. It should be read a chapter at a time, and the various experiments performed with articles that exist in every house. Pieces of stick will make levers; everybody can get a common carpenter's screw; a cotton reel is a pulley; a teapot teaches hydrostatics, because the small column in its spout is able to balance the big column in the vessel itself; it will also teach some hydraulics, because, with a given inclination, it will discharge its contents quicker when full, than when, from being partly empty, the level of the source of supply is not so much above the point of exit as in the former case, and consequently the pressure is less. The habit of understanding the scientific principles that operate in daily concerns is an invaluable one. It is astonishing that men have lived so long in the world, and that the most civilized nations are only beginning to find out that it is desirable to know something about it. Without some knowledge of physics and chemistry, without microscopes and telescopes, the mind is half starved, because so little of nature's operations is understood; and there remains a great gulf of separation between the instructed few and the uninstructed many. Far better would it be—and happily not now difficult or costly—for the average cultivation of youth to be carried at least as far as the rudiments of positive knowledge in the departments we have specified, and then the capacities of society for utility and enjoyment would be a million-fold increased.

INDEX-MAP OF THE MOON.

94 Langrenus.
95 Vendelinus.
96 Petavius.
97 Furnerius.
98 Stöffler.
99 Maurolycus.
100 Barocius.
101 Rabbi Levi.
102 Zagut.
103 Lindenau.
104 Piccolomini.
105 Fracastorius.
106 Rheita.
107 Steinheil.
108 Vlacq.
109 Zach.
110 Mutus.

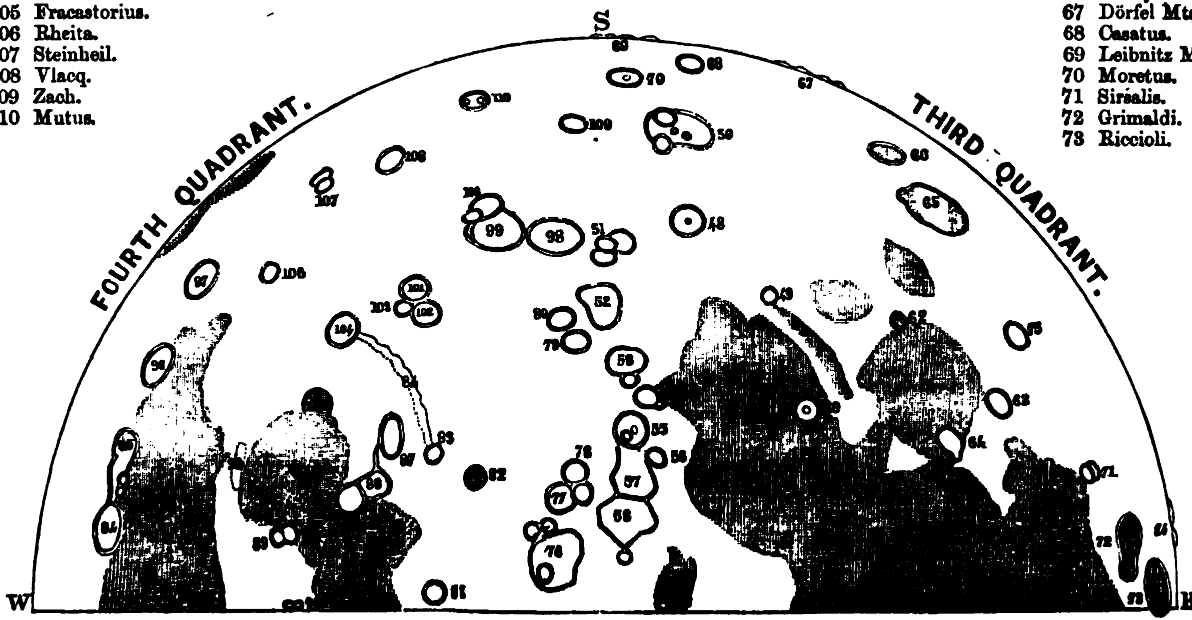
84 Altai Mts.
85 Theophilus.
86 Cyrillus.
87 Catharina.
88 Isidorus.
89 Capella.
90 Censorinus.
91 Taruntius.
92 Messier.
93 Pyrenees.

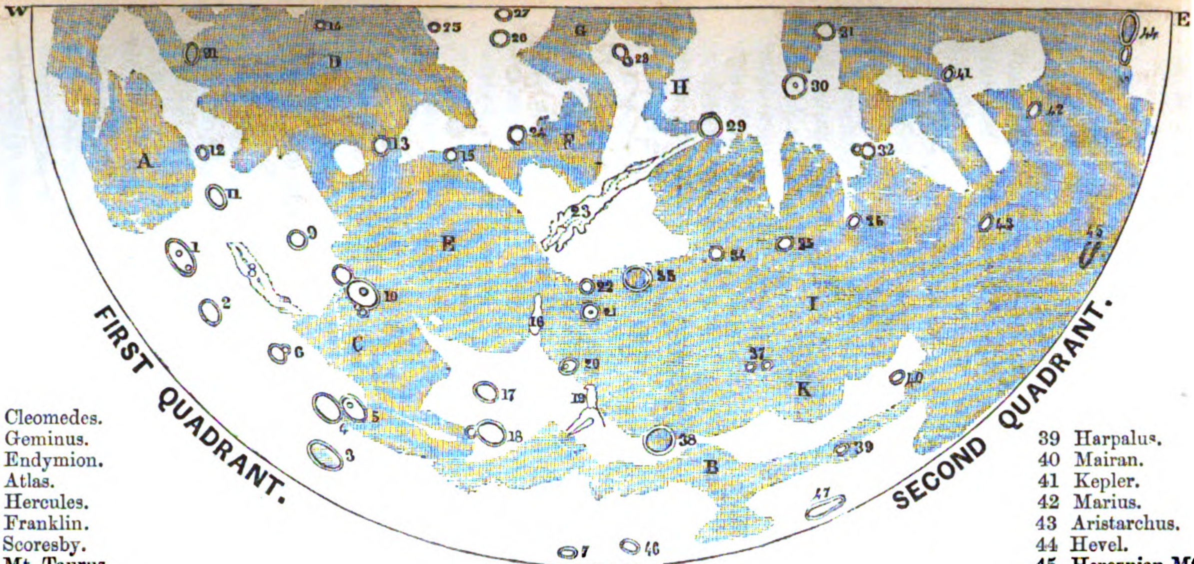
K. Sinus Iridum.
L. Oceanus Procellarum.
M. Mare Nubium.
N. Mare Humorum.

O. Mare Nectaris.
P. Mare Fœcunditatis.

74 D'Alembert Mts.
75 Vieta.
76 Hipparchus.
77 Albategnius.
78 Parrot.
79 Werner.
80 Aliacensis.
81 Delambre.
82 Abulfeda.
83 Tacitus.

56 Alpetragius.
57 Alphonsus.
58 Ptolemæus.
59 Mösting.
60 Bullialdus.
61 Landsberg.
62 Vitello.
63 Mersenius.
64 Gassendi.
65 Schickhard.
66 Phocylides.
67 Dörfel Mts.
68 Casatus.
69 Leibnitz Mts.
70 Moretus.
71 Sirsalis.
72 Grimaldi.
73 Riccioli.





1	Cleomedes.	19	Alps.	A.	Mare Crisium.*	29	Eratosthenes.	39	Harpalus.
2	Geminus.	20	Cassini.	B.	Mare Frigoris.	30	Copernicus.	40	Mairan.
3	Endymion.	21	Aristillus.	C.	Lacus Somniorum.	31	Reinhold.	41	Kepler.
4	Atlas.	22	Autolycus.	D.	Mare Tranquillitatis.	32	Tobias Mayer.	42	Marius.
5	Hercules.	23	Apennines.	E.	Mare Serenitatis.	33	Archimedes.	43	Aristarchus.
6	Franklin.	24	Manilius.	F.	Mare Vaporum.	34	Timocharis.	44	Hevel.
7	Scoresby.	25	Dionysius.	G.	Sinus Medii.	35	Lambert.	45	Hercynian Mts.
8	Mt. Taurus.	26	Agrippa.	H.	Sinus Æstuum.	36	Euler.	46	Anaxagoras.
9	Römer.	27	Godin.	I.	Mare Imbrium.	37	Helicon.	47	Pythagoras.
10	Posidonius.	28	Bode.			38	Plato.	48	Tycho.
11	Macrobius.							49	Cichus.
12	Proclus.							50	Clavius.
13	Plinius.							51	Nasireddin.
14	Maskelyne.							52	Walter.
15	Menelaus.							53	Purbach.
16	Mt. Caucasus.							54	Thebit.
17	Eudoxus.							55	Arzachel.
18	Aristoteles.								

THE MOON. PLANETS OF THE MONTH. DOUBLE STAR. OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

INDEX-MAP OF THE MOON.

The accompanying diagram of the moon is not intended as a pictorial representation of the surface of our satellite, but as a guide to the position of the more conspicuous spots or interesting regions; and beyond this it makes no pretensions.* From the principle of selection which has been adopted, it is hoped that it will be less perplexing to the amateur who is commencing the study of our satellite, than if it were a crowded reduction of a larger map; and while it will assist him in acquiring the nomenclature of the principal features, its more express object will be to enable him to identify the position of the details which it is intended to describe successively in future papers. It has been divided into two halves, in order to avoid the inconvenience of folding; and bisection in an E. and W. direction has been preferred to the more natural one from N. to S., as interfering with much fewer objects. This, however, has entailed the necessity of turning the diagram on its side, that it may present an aspect similar to that of the full moon in an inverting telescope. The grey plains, or so-called seas, are distinguished by Roman capital letters, the craters and mountains by Arabic numerals, corresponding with the accompanying list, which, it will be observed, has been so arranged as to bring the designation as nearly opposite as may be to the spot to which it belongs. The great work of Beer and Mädler being adopted as the standard authority, their order has been followed in the distribution of the numbers, though its appropriateness may not be in every instance as apparent as might be wished. The student is recommended to pay especial attention to the situation of the points of the compass, which differs materially from that recognized almost universally in terrestrial maps. The reason of this peculiarity will be clear if the diagram is turned upside down; it will then represent the full moon as seen on the meridian without a telescope, and the designation of each part of the lunar disc will be found to correspond with the points of the terrestrial compass on every side. This semi-inversion, which arises from our standing face to face with the object, and is exactly that of a common looking-glass, or a front-view

* A much more complete map, twelve inches in diameter, containing every spot included in the nomenclature of Beer and Mädler (404 in all), will be found in the author's little work entitled *Celestial Objects for Common Telescopes.*

reflector, will be a little puzzling at first, and should be thoroughly mastered in order not to get bewildered and lose our way in following the description of details.

We are now prepared to enter upon an individual examination of the most conspicuous wonders of our satellite; a few preliminary remarks, however, may be expedient, to put the student in possession of such information as he may subsequently find useful. With regard to the lunar nomenclature, this, though now reduced to a settled arrangement, has been formerly subject to great variation. Hevel, the celebrated observer of Dantzig, who flourished during the latter half of the seventeenth century, was the first to designate the various regions and spots by names; these he derived from some kind of analogy between the configurations of the terrestrial and lunar surfaces—occasionally a tolerably happy one, but generally speaking very inappropriate, as well as inadequate to meet the future requirements of advancing knowledge. His successor, Riccioli, though an inferior observer, improved considerably upon this method, by the adoption of Hevel's earlier idea, which had been abandoned from the fear of apparent partiality, and which consisted in the employment of the names of eminent scientific men—among these taking care not to forget *his own.* He changed, at the same time, Hevel's appellations of the so-called seas, for others referring to supposed influences exercised by the moon upon the atmosphere and productions of the earth, and altered in a similar way those of the higher districts and mountain ranges; but in the latter case his designations have fallen into disuse, or have, in a few instances, been unable to supplant the earlier ones. Fortunately for Riccioli's scheme, it is of an elastic character; the constant increase in the number of scientific names admitting of its extended application in proportion to the increased number of spots which modern accuracy seeks to distinguish; such an extension is, in fact, being carried out at the present time by our own zealous and able selenographer, Mr. Birt; and this nomenclature may now be considered as established beyond the prospect of change. As, however, it would be obviously impossible to find separate designations in this way for all the objects which require to be identified, Schröter introduced the use of the letters of the Roman and Greek alphabets for the minor details in each of his "selenotopographical" plates; and this plan has been reduced by Beer and Mädler to a regular system, which it may be desirable to explain in this place, as their letter-press is not always in the hands of the possessors of their map. Every object which has no proper name is referred to the nearest spot so designated; if a mountain, it is indicated by a Greek, if a hollow, by a Latin

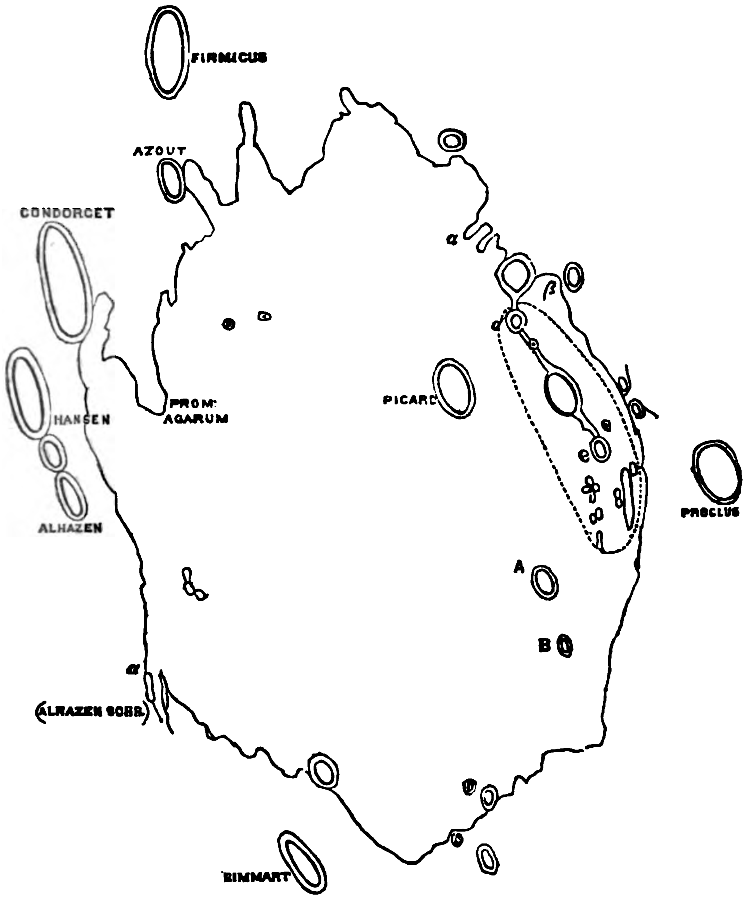
letter subjoined to the name of the principal spot; capital letters are employed for points whose position has been determined by measurement, smaller ones for such as are filled in by the eye; these letters standing, especially when so required, on the side of the object next to the spot whence it is named; and the alphabetical succession being determined by the relative conspicuousness of the features when best seen. The system is an ingenious one, but not in all cases easy, or clear, in its application. A more comprehensive and universally available mode of designating every spot worthy of notice on the lunar disc, is understood to be in the course of preparation by Mr. Birt, and will be a great acquisition to astronomers.

In order to be able to give some verbal description of the features of the moon, as well as to assist the investigation of supposed changes, it is material to employ a scale of brightness, in which the different degrees, though depending of necessity upon mere estimation, are expressed by numbers. Schröter and Lohrmann employed a scale of ten degrees for this purpose, and have been followed by B. and M., who, making the absolute shadows $= 0$, assign 1° to 3° to the dark grey districts, 4° and 5° to the lighter grey, 6° and 7° to the white regions, and 8° to 10° to the glittering spots. 1°, 9°, and 10° are of infrequent occurrence. 2° and 3° denote the common tone of the "maria," 4° to 6° that of the brighter landscapes, 4° to 7° the rings of most, and the interiors of many craters, 6°, 7°, and 8° express the brightness of many peaks and ridges; but it is remarked by B. and M. that these are never, generally speaking, the most elevated points in the district.

It is not very probable that many of our readers would wish to undertake the measurement of the heights and depths of the surface. The task would not only be a somewhat troublesome, but to a considerable extent a superfluous one, as it has already been performed with much accuracy by Beer and Mädler, in no less than 1095 cases, comprising most of the principal and conveniently accessible features of the moon. Many of their results will be found in the following papers; but they will be given in round numbers, as the extreme preciseness, extending even to single *toises*, with which they are specified by those authorities, has of course no other value than that of showing the carefulness of the observation. As all these measures are determined by the lengths of shadows, a trifling difference, as to which we have very little means of judging, in the level of the ground where the shadow terminates, will have so great an influence on the final result, that no such exceeding accuracy is possible. No doubt, much might yet be done, if it were thought desirable to obtain more perfect correctness, by taking the average of many measures, obtained at different times from

different lengths of shadow; and should any observer, possessing a good micrometer, and facility in the use of it, wish to offer such a contribution to selenography, he will find all the necessary formulæ in *Der Mond* (The Moon) of Beer and Mädler.

As to the instrument to be employed, many of the lunar features are so conspicuous, that any good telescope will suffice



[The above diagram of the Mare Crisium contains the principal features in the map of B. and M.; the portion, however, surrounded by a dotted line is altered to correspond with my own observations.]

to show them. Of course, a larger instrument would be preferable; but even a 2-inch object-glass with a good astronomical eye-piece will reveal wonders enough to be a constant source of interest. In the case of a very large aperture and an

eye sensitive to light, much comfort may be experienced from the adoption of a screen-glass, such as is used for solar observations, but, of course, of a much lighter hue: a pale green has been recommended by Challis as very suitable. High magnifiers are seldom of much value; they contract the field unpleasantly, and increase the apparent motion of the object, unless a driving-power is at hand. From 100 to 300 times may be mentioned as most generally serviceable. Beer and Mädler never exceeded the latter in their original investigation with an aperture of nearly 4¾ inches, though Mädler, after succeeding W. Struve at Dorpat, employed powers of 600 and even 1100*, with the great achromatic of 9·6 inches, in that observatory.

We begin with one of the most familiarly-known spots, the—

MARE CRISIUM.

The remarkably well-defined grey plain, marked A in our Index-map, has received from Riccioli the name of Mare Crisium,† "the Sea of Crises," by which, as there is nothing of an astrologico-political character in his nomenclature, he probably meant changes of weather; and, if so, has, as far as he could, commended it to the especial attention of English astronomers. It is so distinctly and strongly bounded as to be always easy of identification, lying near the W. limb, and not far N. of the lunar equator: and we cannot wonder at the impression of the earlier observers, who imagined, in such a striking level, the exact counterpart of a terrestrial sea, or great lake encircled by a rampart of mountains. Such, however, was not the full conviction of Hevel, though he adopted the name as the closest approximation that he could find; and such an idea will not be revived in the present day, so multiplied and so distinct are the roughenings of the surface which modern instruments will show, and so clear the view into the depths of craters, which would be the chief receptacles of any fluid existing there.‡ The "Mare" before us is evidently a very interesting one; its oblique position, however, subjects it to so great a foreshortening that its interior is studied to much less advantage than if it occupied a more central situation. From its nearness to the edge of the disc its apparent form is much

* These were, however, probably much exaggerated. Encke found that the 600 power on a similar achromatic at Berlin, by the same maker, proved to be only 400 by the dynameter.

† Certainly little imagining that any future astronomer would ever quote its genitive case as "Mare Crisii," which, however, B. and M. have done in one instance, p. 194.

‡ Arago, however, thinks this inference not conclusive, as the uneven, craggy bottom of our oceans may be distinctly seen from a great height. It might be added that fresh water would be still more translucent.

affected by libration; its measure from E. to W. varying at different times from 0·6 to 0·8 of that from N. to S. Its general appearance is that of an irregular oval extended along the lunar meridian, and we should not have supposed, from mere inspection, that in consequence of the perspective foreshortening it is actually elliptical the opposite way, its longer axis pointing towards the eye, or more correctly from W.S.W. to E.S.E. of the lunar compass. In this direction it extends nearly 354 English miles; from N. to S. about 280 miles, or about the distance from London to Newcastle. Its area is about 78,000 square miles,* $\frac{1}{111}$th part of the visible hemisphere of the moon, ten times the surface of Yorkshire and Lancashire united, or a little more than half as much again as the area of England and Wales, though of a very dissimilar form. Of this, however, only $\frac{3}{5}$ths can be considered level. Its border is not everywhere continuous, being interrupted in some places, especially towards the W., on which side narrow arms or straits penetrate the mountains, and communicate with smaller grey surfaces. No "sea" is equally dark in comparison with its mountain boundaries, having generally only 2° to $2\frac{1}{2}$° of light, grey in tone, mingled with dark green; but the latter colour, according to B. and M., for I have never seen it, is perceptible only a few days before and after the full moon, with a large aperture, a moderate power, and very favourable weather, and, except near the *Promontorium Agarum*, nowhere extends to the W. limit. It has been represented by Professor C. Piazzi Smyth, in his three general views of this surface, sketched with the feeling and spirit of a genuine artist, but entering little into detail. "Practice and experience," he says, "brought to view so many decided and interesting features of colour," that the idea of employing black and white alone had to be abandoned. The surrounding region ranks as 5° of light, in some spots rising to 6° and 7°. Mountains encompass it all round, attaining a considerable height on the NE. side; here, in a line passing through *Picard* A and B, B. and M. have measured a summit of 13,300 feet, and further to the S.S.E. others of 7,150, 11,300, and 6,700 feet; these decline at once precipitously to the plain, from which they must exhibit a magnificent spectacle, and over which they must command a marvellous prospect. Such views are of frequent occurrence in the moon, and the rapid rounding-off of so com-

* Something appears to have gone wrong here in the text of B. and M., as, assuming their length and breadth to be correct, the area they have given is considerably too small. I have corrected this; but am sorry to add that something has gone much more wrong in this place in my little book, entitled *Celestial Objects for Common Telescopes*, where, from using an erroneous multiplier, I have made the area only 14,260 square miles! I find, however, a similar mistake in *Cosmos*, iv. 492 (Bohn).

paratively small a globe, and the sharpness of outline and detail consequent upon the absence of a vaporous atmosphere, must give them an effect which would seem very astonishing to a terrestrial spectator. Further to the S. this E. coast declines to a kind of pass, not well shown by B. and M., who admit that this part of their map is deficient in boldness, but much better drawn by Schröter: on the other side of this interruption the mountains rise again, and on the S. the great summits *Picard* α and β spring up to 14,200 and 15,600 feet, rivalling our loftiest Alpine peaks; beyond these the great headland, named *Promontorium Agarum* by Hevel, runs out into the plain with a rounded summit nearly 11,000 feet in height, supported by cliffs 8° bright a few days after the full, when they are most directly enlightened. Birt has detected a crater upon it. In this direction broad bays and "fiords" penetrate the mountain border towards the S., and in the young crescent are filled with shade. The W. edge of the "Mare" is less boldly defined between the craters *Condorcet* and *Eimmart*, and is made up of hillocks and ridges, intermixed with isolated mountains, like lofty islands in the sea.

It was among these that Schröter found a distinct and always recognizable crater, about twenty-three miles in diameter, remarkable for its dark grey colour under every angle of illumination, to which he gave the name *Alhazen*, and which, from its proximity to the W. limb, he continually used for the purpose of measuring the libration. Having thus had it constantly before his eyes, he was the more surprised at its variable aspect: at first it was a depressed grey surface within a ring; then frequently, and even in the 27-foot reflector, like a longish flat ridge, and these appearances were interchangeable; sometimes, too, while the neighbouring objects were as sharp as usual, it would be so indistinct that "he did not know what to make of it:" and on one occasion (1797, March 1), after ten years of observation, when libration was most unfavourable, as having carried its W. edge to within 28″ of the limb, and the terminator had crossed over to the other side of the "Mare," and it consequently ought to have been very ill seen, he found it extraordinarily distinct: its form, however, was one previously entirely unknown, that of a very deep bright irregular crater, whose ring was barely complete towards the S., and open, with a prolongation of its E. edge, at the opposite end. The cause of this difference, he thought, must lie in some modification of the lunar atmosphere, such as he believed that he could trace in many instances, which would be capable of masking the depths of a crater, and giving it a grey and flat aspect, or changing altogether its appearance. In Bode's *Jahrbuch* for 1825, Kunowsky, an accurate observer, asserted

that *Alhazen* was no longer to be found under any form, and that the region seemed quite different; nor did B. and M. come to any other conclusion. They could discover no ring-shaped mountain there—on the contrary, an abundance of partly isolated, partly connected hills and mountains, and long, dark, curved valleys and bays; so, knowing the "great uncertainty"* of Schröter's drawings, they fixed upon a crater considerably further S. to bear the name, as it seemed to correspond best with Schröter's object. On the other hand, Pastorff and Harding stated, in the *Jahrbuch* for 1827, that they could always see *Alhazen;* and Köhler, under the year 1828, asserts that it has not disappeared, but is very variable in aspect; and he has given several figures showing that it corresponds with B. and M.'s *Alhazen a,* the loftiest mountain in the region, 7700 feet above the valley to the W. On the E. side of this height, between it and some low ridges, lies a deep hollow, with openings to the "Mare," the colour of which varies with its illumination, while the mountain itself might, from its shape, sometimes take the aspect of a ring. And with this B. and M. seem satisfied, notwithstanding their having changed the name. At the commencement of 1862, Birt recovered this spot, exactly in the position given by Schröter, and has described it in detail as a deep valley between two mountain ranges, of which the W. (*a* of B. and M.) is much the higher: these are quite separate at their S. end, but under many circumstances are barely distinguishable from the ring of a crater. On the E. side of *Alhazen,* where Birt perceived one or two minute craters, Gruithuisen fancied that certain rows of hillocks might contain the habitations of Selenites! and here, too, he noticed rapid changes from bright to grey under increasing sunshine, which, being contrary to photometrical principles, he was disposed to refer to cultivation. Fanciful and absurd as his speculations often are, we should not do right in systematically rejecting his facts, some of which may be worthy of further investigation.

* That there is occasional cause for this censure need not be denied, though coarseness and rudeness of delineation would be a more appropriate characteristic. But still the old Hanoverian astronomer was far from always deserving the disparaging remarks of his successors. For instance, they have brought it as a charge against him that he drew the *Mare Crisium,* "with all its environs," in a single evening, and has given it a bordering so unlike the truth, that it is scarcely sufficient for its recognition (a bold and strange assertion), and is quite useless for the identification of details; and they ask how it is possible on such data to found ideas as to the existence of atmospheric or volcanic changes. It would hardly be supposed that Schröter's own expressions are, that as a single evening is too short for the examination, measurement, and delineation of such a region, and it would be wrong, and misleading, to piece together separate drawings taken under different circumstances, his sketch is expressly confined to the interior level, and the remarkable objects in the mountain border, but that the latter is merely laid down in a general way.

The grey interior plain contains many irregularities of surface, of which the principal is a crater called *Picard*, at least twenty-one miles in diameter. *Twenty-one miles!* what a scale this gives the lunar student in gazing at this marvellous landscape! A spectator stationed here would see the earth like a great globe, between three and four times of the apparent size of the moon to us, standing at an elevation of about 34° in its W.S.W. sky, passing through all the varied phases of the moon, and only shifting its place a little in consequence of libration. The sun, on the contrary, reaches 74° to 77° of altitude at noon, and the interior hollow is for 120h. a shadowless and, as we should suppose, an oppressively burning basin. It is surrounded by a tint somewhat darker than that of the rest of the plain, above which its W. wall ascends 3050 feet, but 5300 above the bottom of the crater. Schröter has given the latter at least 3000 feet more, but no measures can be trusted taken under so unfavourable an angle. The smaller craters, *Picard* A and B, are steeper and deeper, and retain almost all their shadow when it is quitting their more imposing neighbour. Within the line of the E. coast lie several high mountains, either isolated or connected by low ridges, as is frequently observed in the moon. These are so ill-represented in the great map of B. and M. that they have given a special drawing with the letter-press, full of minute detail. Like all their delineations towards the limb, it suffers materially in effect from the attempt to represent both sides of every mountain as in a bird's-eye view, when one side only is visible in perspective. It would not, indeed, have been practicable to avoid this, while persevering consistently in the conventional style adopted in maps; but the result is unfavourable in all situations lying obliquely to the eye. Independently however of this awkwardness, for which the observer must learn to make allowance, I am obliged to remark that I cannot succeed in reconciling it with what I have seen in the same region, and have roughly indicated in the accompanying diagram. One of these mountains which B. and M. have designated *e* (affixing the letter, however, in their large map not to the proper object, but to a mountain about $\frac{3}{4}$° N.N.W.), terminates a low serpentine ridge running up from the crater *Picard d*, and contains, beneath its summit (the loftiest point in the neighbourhood,* 5500 feet above its W. base), a distinct crater, first represented by Cassini; of the existence of this there is no question: but its W. is so much higher, broader, and brighter than its E. wall

* Schröter however rates it differently. He gives it 4982 feet, but thinks some of its neighbours higher. I have also noticed it not casting the longest shadow; but in this there is much uncertainty, for want of an uniformly level base.

that under many angles of illumination it assumes the appearance of a long mountain ridge. Such is the explanation offered by B. and M. (after Kunowsky) of the singular changes in form and shading which long perplexed Schröter, and which led him to infer atmospheric if not volcanic changes; and it seems probable that in this instance the more modern astronomers have the best of the argument. The question however is not altogether clear. Schröter's observations upon this group of mountains are too numerous to be recited here; they refer chiefly to the varied appearance of shadows, longer, shorter, imperceptible, or unusually directed, at different times, but under nearly similar angles of illumination; to unaccountable changes in the forms of mountains; and to the discovery, and subsequent invisibility, of ridges or hillocks in well-known and often observed situations. There can be no doubt that, as he was himself aware, a slight difference in the conditions of illumination and reflection may produce a very disproportionate change of aspect; still, there is much weight in his remark that this must not be pushed too far, or we should find similar variations occurring from the moon's progress during the course of a single observation extended through several hours, which has never yet been found to take place. To one source of error he was perhaps not sufficiently alive—the increased perception of the true nature of a distant or obscure object, in proportion as it becomes familiar to the eye. It certainly does not seem at all likely that the crater *e* was ever seen in actual eruption by Schröter, as he was inclined to suppose; but we must bear in mind that, as eruptions of some kind—whatever that kind may be—must have taken place upon the moon times without number, there is no antecedent impossibility in such an idea. It must be admitted that the region is a curious one, and well adapted for an inquiry which may be worth the while of future observers, whether all these variations are due solely to differences of illumination and libration, or whether there may be, as Schröter supposed, occasional modifications of a lunar amosphere, capable under certain circumstances of impeding or perverting our view; and it would be unphilosophical and unwise to allow the greater probability of the former alternative to stifle the inquiry. In order to bring out of it any successful result, Schröter's observations would lead us, not merely to note the aspect of the crater *e* in all positions relative to the sun and earth, but also to examine the proportionate lengths of the shadows of the other mountains in the group, and the first and last appearance of their summits at the time of lunar sunrise or sunset. My own observations have not been sufficiently consecutive to be of real service in establishing anything. To the general reader much that has

been here brought forward may appear of trifling interest, but as there is reason to believe that selenography is now receiving a powerful impulse, it may be useful to the student to know what difficulties and uncertainties may attend his own path, and what has, or has not, been done to remove them. He will not regret having made acquaintance with them at his first essay.

We must not omit some other curious observations which include a more extended range. Such was that of Schröter, who upon one ocasion, when the moon was 2d. 23h. old, found the whole W. portion of the "Mare" unusually bright, and of a yellowish hue, so as scarcely to be distinguished from its mountain border; this appearance, unprecedented here, or in any similar level, fading away entirely into the ordinary grey on the opposite side of the plain. At another time, the moon's age being 6d. 7h., he saw "an incredible, innumerable multitude" of bright specks in the grey surface, chiefly in places where no known object existed. A subsequent examination of other grey plains, under a similar incidence of light, showed him nothing equally remarkable. More than two years afterwards, however, under a very different and almost vertical illumination, the moon being 11d. 19h. old, the scene was renewed; the plain was so interwoven and variegated, like the veins of an animal, or an irregular tissue, with streaks of light, and actually innumerable bright points, that it would have been difficult for the most skilful artist to give a sufficiently striking representation of such a magnificent scene. Two days afterwards this beautiful effect had disappeared, and nothing of the kind could be traced in the *Mare Serenitatis* on the neighbouring levels, where the sun had by that time attained a corresponding elevation.* No other similar instance was ever recorded by him; but the following from B. and M. (who characteristically ignore what he has described) was evidently one of the same nature. The moon being between 10d. and 11d. old, they noticed that the greater part of a white streak which runs from *Proclus* (No. 12 in the Index-Map) towards *Picard* B was resolved, through an area of 230 miles by 28, into fully 150 points of light, like a jet of water dispersed into spray—the whole plain appearing also more speckled than usual. I was once (1832, July 4) so fortunate as to witness something of the kind, about the time of first quarter, when the whole plain, notwithstanding the imperfection of my instrument—a fluid achromatic of four inches, upon Barlow's plan—was seen beautifully mottled with light and shade, a spot at the N. extremity nearly rivalling the brightness of *Proclus*. It is

* But from which the rays would be reflected at a very different angle to the spectator—a circumstance which Schröter does not notice.

certainly not easy to account for the infrequency and uncertainty of such observations. B. and M. could occasionally perceive, in very clear air, a multitude of the minutest points just on the night-side of the terminator, indicating a surface less perfectly level than it might otherwise appear. They could trace also, from their shadows, ridges of about 60 feet in height, and 2½ to 4 or 5 miles wide. There are many more considerable ridges in the plain, running generally from N. to S., branching and reuniting, rising to knolls at their intersections, and sometimes enclosing circular hollows. The remarkable peculiarity to which Schröter paid so much attention, as existing everywhere in the moon, that these ridges form lines of communication between more conspicuous objects, is not without examples here.

A few other features remain to be described. Olbers discovered, with a 3¾-inch Dollond, in 1794, two minute craters between Picard and Condorcet. Five more of very trifling depth are mentioned by B. and M. in the same region, but not drawn, having been detected after the publication of this part of the map. The *Mare Crisium*, indeed, is executed altogether in an inferior way, as though it had been an early attempt. They have omitted a few minute craters figured by Schröter near the W. and N. border; and many of these objects are of such difficult visibility that discrepancies must here cause no surprise. Nevertheless, insignificant as they may appear, they are of much value to the selenographer, as they admit of close comparison with regard to relative size, and consequently afford an especially fair prospect of discovering the progress—should it exist—of eruptive action.

Picard d, a crater discovered by Cassini at the S. end of the serpentine ridge, was noticed by Schröter to be of extraordinary depth, deeper than *Picard*, from its long retention of shade.* Immediately S. of it lies a curious object first perceived by him, an ancient looking ring with a central mound, resembling much a walled plain—such as we shall be introduced to hereafter—in a state of degradation and decay. He could not always find it afterwards, though under corresponding circumstances, and hence was led to infer some atmospheric obscuration. Although B. and M. have introduced abundant details in this district, some of which I have not seen, they failed to notice that the curve which the winding ridge, so frequently mentioned, forms towards the E. is in reality the half of a circle (projected of course as an ellipse), of which I have distinctly made out the remainder, as sketched in the diagram.

* This observer has noticed that many of the smaller class of craters are so remarkable on this account that there is cause to suspect some illusion, as true shade could hardly remain so long. This may be a point worthy of attention.

It is of a character which we shall not unfrequently meet with in our lunar travels, resembling a bowl nearly full of a fluid into which it is obliquely sinking; in point of size and age it seems more the counterpart than is represented in the diagram, of the circle already mentioned on the other side of *Picard d.* I first perceived it, 1863, Oct. 28, and have since repeatedly seen it, under such varied incidence of light, that I cannot doubt its reality, or understand how it is to be satisfactorily reconciled with B. and M's. detail here. They have also omitted two very minute craters, one a little way S.S.E. of *e*, where they, Schröter, and myself at other times have seen an elevation; the other between my ring and *Picard d*, lying apparently on the serpentine ridge, in a part which was not visible when the diagram was made, but is readily seen under the opposite illumination. The pass or gateway through the E. mountains is guarded, as I have several times noticed, by two small craters, both seen by Schröter, but one only clearly represented by B. and M. That on the N. side was not perceived by the former observer till after he had had the spot under his eyes for more than three years; yet there is no reason to suppose it new; such oversights are not very uncommon.

B. and M. have remarked it as a singular fact, that no central hill is to be found in any of the craters in or around this great plain, the nearest so characterized being *Taruntius* and *Macrobius* (91 and 11 in the Index-Map), if we except a feeble and somewhat uncertain trace in *Azout*. I have, however, entered a low central hill, as visible in *Picard*, and another more distinct in *Picard* A, with a $3\frac{7}{10}$-inch aperture, 1834, Sept. 19; and with my present telescope I distinctly found, 1863, Oct. 28, that both these craters have interiors rough with hillocks, especially A, which has an irregular mound lying on the inner slope of its N. end; the effect being much as though masses of soft mud had been thrown at random into the interior. Gruithuisen states that near *Picard* some remarkable white ridges are to be seen, in part as straight and regular as artificial walls.

In consequence of the great differences resulting from libration, no certain age of the moon can be mentioned as the most suitable for the study of this region. Opportunities must be carefully watched in the young crescent and the early wane. A grand effect is produced during the progress of the lunar sunset, when the great boundary mountains on each side of the E. gateway fling their ponderous shadows to the terminator, inclosing a small portion of the plain, which still enjoys the declining ray. This has been well figured by Schröter, and I have seen it 3d. 4h. after the full moon.

PLANETS OF THE MONTH.

We have so long been without the charm of planets in our evening skies, that we shall hail their return with pleasure during the present month. Jupiter and Saturn have now come back to us. Saturn will be in opposition to the sun on April 4, and therefore on the meridian at midnight, between α and γ *Virginis*, but some way N. of the joining line. His rising will be then about 6½h. The ring is becoming broader every season—its proportions being now about 43½″ by 29″, so that its marvellous details are coming fairly into view, while the intersection of its outline with that of the ball renders the combined form more elegant than it would be with a wider opening. Jupiter rises later, about 9½h. in the middle of the month, and has, unfortunately, a considerable S. declination among the stars of *Libra*. Those who are interested in the study of his features, or the transits of his satellites, will nevertheless, no doubt, attempt to renew their observations. The transits before midnight will be the following:—April 8th, I. will leave the disc at 11h. 44m.—10th, the shadow of II. will enter at 11h. 12m., the satellite following at 12h. 41m.—15th, I. will enter at 11h. 18m., its shadow being already on the disc.

Mercury will be at his greatest E. elongation at the end of the month; and though not in the most favourable part of his orbit, the great eccentricity of which makes much difference, yet, having considerable N. declination, there will be a chance of his being fairly visible in the evening twilight.

DOUBLE STAR.

Saturn will be lingering so near one of these objects during this month, that it would seem strange not to include it in our list. It will be found a little *sf* the planet, and is—

123. ϑ *Virginis*. 7″·1. 345°·2. 4½ and 9 (1831·15). Pale white and violet. An optical pair, rendered triple by the addition of a third 10 mag. star, at 65″ and 295°. It is a pretty though minute object. I thought the closer attendant greenish or bluish, with 3$\frac{7}{10}$ inches, 1856·35; but a larger aperture is necessary to estimate the colour of such feeble points, and I have not examined it with my present means.

OCCULTATIONS.

April 11th. χ^2 Orionis, 6 mag., will be hidden from 6h. 28m. to 7h. 38m.—20th, *g* Virginis, 6 mag., from 8h. 40m. to 9h. 48m.—22nd, B. A. C. 4896, 6 mag., from 9h. 23m. to 10h. 25m.

THE EXTINGUISHER MOSSES.

BY M. G. CAMPBELL.

THE *Encalyptæ*, or Extinguisher Mosses, form a very natural group, which, notwithstanding the extremely variable peristome, are easily distinguished from all others by the structure and comparative size of the calyptra, which is cylindrico-campanulate below, longer than the capsule, and with a rather long rostrum, like a little tower or round spire at the apex, while at the base it is usually fringed, torn, or crenate, and is persistent, defying wind and rain, and falling away only with the lid when the spores are perfectly ripe. These spores are granular, and of a yellowish-brown colour. The species may be found growing on dry or moderately moist rocks, and on walls and stones, especially those of calcareous origin. The stems are branched, here and there beset with radicles, erect, bearing terminal seta, and perennial; the fruit-stalk is so firm and tenacious as to remain on the stems for several seasons. The generic name is derived from ἐν *in*, and καλυπτὸς, covered, shrouded, or enveloped, *i. e.*, *covered in*, in allusion to the persistent, bell-shaped calyptra entirely enclosing the capsule.

The most generally met with is *Encalypta vulgaris*, or the *common extinguisher moss*, of which we give a considerably magnified illustration, with a naked capsule still more magnified, and having on its lid, with long tapering beak. The moss may be found growing on stone walls, also on banks and rocks, especially such as are of calcareous nature. It has rather short stems, rarely half an inch long, but branched and radiculose. Its leaves are erect, more or less spreading, and, in general, more or less apiculate, though in one variety they are obtuse and concave at the apex; the margin plane, crenulate, or scabrous with papillæ; the nerve strong, purplish, often more or less excurrent, but sometimes ceasing below the apex, and the leaves are somewhat crisped when dry. The capsule is subcylindrical, smooth when moist, but frequently more or less plicated or rugose when dry; of thin texture, and somewhat tapering from the base. The annulus is simple and persistent, and being coloured at an

ENCALYPTA VULGARIS.

early stage, is easily seen through the semi-transparent, greenish calyptra, which is papillose at the apex, and said to be entire at the base, though usually more or less torn in its separation from the vaginula, but it is never fringed as in *Encalypta ciliata;* and is entire in the sense of being *of one piece,* self composed, as well as in the botanical sense of being without teeth or notches in the margin; it resembles a little fairy extinguisher placed over a miniature wax-taper, as much as to say, "You must not be lighted till the boisterous winds of March, and the tearful days of April, give place to serener skies and a dryer atmosphere;" but during these months, March and April, the fruit is ripening, and towards the end of April or early in May, extinguisher and lid, which have been such close friends during all the rough weather, fall off together, and give the now matured spores, which are rather large for the size of the moss, leave to escape and develop the functions of vitality that lurk within them. The peristome is frequently absent, and at all times is extremely fugacious and fragile; when perfect, it consists of sixteen teeth, pale and sub-erect, seldom rising much above the orifice of the capsule.

There are several varieties, slightly differing from each other, one differing only in an elongated stem and larger leaves, another in having the leaves piliferous, another in having an oblique capsule, but all so nearly resembling the normal form, as to be easily recognized for *Encalypta vulgaris.* From the same patch, a few yards in extent, and growing on a stone wall on the Cotteswold range of hills, we have gathered some specimens with a full mouth of sixteen teeth, others with one, two, or three only, and others again quite destitute of peristome.

The calyptra attains its full size before its separation from the vaginula, and even before the fruit becomes appreciable at the summit of the fruit-stalk, which is coiled up within the calyptra in this early stage, and it is interesting to witness its development. At first the base of the calyptra is turned up inwardly upon a little mass of spongy tissue, which crowns the depressed conical summit of the vaginula, and when torn away by advancing growth, it is found too firmly adherent to come clean off, so that it leaves a circular fragment from its base, like a little coronet, to crown the vaginula. The reddish fruit-stalk, which is about half an inch long, twists towards the right.

In *Encalypta ciliata,* or the *fringed extinguisher moss,* the fruit-stalk twists towards the left, the vaginula is sub-cylindrical, and the pale yellowish, smooth calyptra is distinctly fringed at the base, the fringe being derived from the spongy conical mass of cellular tissue which surmounts the vaginula, and, therefore, being of laxer texture, and paler than the calyptra

itself. This fringe is inflexed when moist, and is sometimes deciduous.

The capsule of *E. ciliata* is of a bright chestnut colour, sub-cylindrical, very smooth, slightly constricted below the mouth, but without an annulus, and having thicker walls than those of *E. vulgaris.* The teeth of the peristome, lanceolate in form, and sixteen in number, are marked with transverse bars, somewhat prominent externally, and inserted below the orifice of the capsule; they are of a reddish hue, converge when moist, but remain erect in a dry state. The spores are granular, and the fruit-stalk, instead of being reddish as in *E. vulgaris,* is yellow. The stems are loosely tufted, about half an inch long or more, branched and bearing oblong-ovate leaves of a brighter green than those of *E. vulgaris,* broader and less crisped when dry, the margin plane in the upper part, distinctly recurved below, somewhat crenulate at the apex, and with an excurrent nerve forming a slight mucro.

The fruiting season of *E. ciliata* is two months later than that of *E. vulgaris,* viz., June and July. It is found on rocks in the mountainous parts of England, Scotland, Wales, and Ireland. In both the inflorescence is monoicous, as is the case with *Encalypta commutata,* and *Encalypta rhabdocarpa.*

E. commutata, or the *sharp-leaved extinguisher moss,* has also branched and radiculose stems, which are slender and about an inch long, with ovate-lanceolate leaves, concave, acuminate, slightly undulated, more or less spreading and squarrose from an erect sheathing base, and having an excurrent nerve.

The capsule is smooth, sub-cylindrical, of thinnish texture, and seated on a reddish fruit-stalk. It has a simple annulus, but no peristome; and the calyptra is smooth all over, jagged and uneven at the base, but not fringed. The vaginula, as in *E. vulgaris,* is crowned by a conical cap of spongy tissue, whose base is bordered by a circlet torn from the base of the calyptra.

The barren flowers of *E. ciliata* are found near the perichetium, they are gemmiform, but only three leaved; those of *E. commutata* are six-leaved, and are either axillary, or terminal on a branch, accompanied by numerous antheridia and paraphyses; but *E. commutata* is sufficiently distinguished by its taper-pointed squarrose leaves, which are its unfailing characteristics. It appears to be limited in distribution, but grows near the summits of the Scottish mountains, and fruits in July and August.

Encalypta rhabdocarpa or the *rib-fruited extinguisher moss,* like the rest of the genus, has branched and radiculose stems, about half an inch long or rather more. Its leaves are moderately spreading, lanceolate or ovate-oblong, acuminate and

mucronate, or sometimes piliferous, concave, with a nerve thinner and paler than in *E. vulgaris*, generally excurrent, but sometimes ceasing below the apex. The capsule is of an oblong form, striated, somewhat apophysate, ribbed and strongly furrowed when dry; the broad, longitudinal, coloured striæ distinguishing it from all others. The fruit-stalk is red and twists towards the right. The calyptra is conico-campanulate, yellowish, scabrous or rugged at the apex, and slightly jagged or uneven at the base. The annulus is simple and the peristome persistent, consisting of sixteen lanceolate, firm, transversely barred teeth, which are sometimes marked with a medial line, as if to show them to be double. They are inserted below the orifice of the capsule, and their position is erect when dry. The vaginula resembles that of *E. vulgaris*, with its little crown arising from the same cause; but the calyptra of *rhabdocarpa* is shorter, wider, and of a darker hue, the leaves more acute and tapering, and the fruiting season is July and August; its habitats, the Scotch mountains, and Ben Bulben, Ireland.

The only remaining British species is the spiral-fruited *extinguisher moss, Encalypta streptocarpa*, whose inflorescence, unlike the other species, is dioicous. In this the elongated stems, from one to two inches long, or even more, are still branched and radiculose. It grows in shady situations, on limestone or mortared walls, etc., sometimes on chalky banks, or on a marly soil, often in extensive patches, but is rarely found in fruit. The walls of a bridge near Dunkeld are mentioned as one of its fruiting habitats. It has also been found in various localities in Derbyshire, and near Bolton Bridge in Yorkshire. It fruits in the month of August.

From its great length of stem, compared with the other members of the genus, one of our muscologists named it *Encalypta grandis*, but *streptocarpa*, from *στρεπτὸς*, writhed, twisted, or twined, and *καρπὸς*, fruit, is far too graphic to be superseded by any other, its sub-cylindrical capsule being, when ripe and dry, marked with eight or nine spiral furrows, and ultimately twisted in the same direction towards the left. It has a compound, dehiscent annulus, and a double peristome, inserted very little below the orifice, the outer one consisting of sixteen long, narrow, nearly filiform, nodulose teeth, almost half as long as the capsule, marked with a medial line, and confluent at the base. They are of a purplish red, and erect, but slightly reflexed when dry. The inner peristome is formed of yellowish-brown ciliæ, which alternate with the outer teeth, are about half their length, adhere closely to them, and unite in their lower half into a plicated membrane. The spores are small and smooth, the barren-flowered plants more

slender than the fertile ones, their flowers gemmiform and terminal.

The leaves are sub-erect, ligulate, or strap-shaped, obtuse and cuculate or hooded, at the apex, slightly crisped, or twisted when dry, with a purplish nerve ceasing at or near the apex; the upper leaves of a light green, the lower brownish, the perichætial leaves approaching to obovate at the base, lanceolate subulate above, and erect.

The calyptra is longer than in most of the species, subcylindrical, rostellate, approaching to subulate, rough and spinulose at the apex, lacinated, at first somewhat fringed at the base, of a yellowish brown colour, and coriaceous consistence. Its lacinated base arising from the same cause as that of *E. ciliata, i.e.*, from the spongy tissue crowning the vaginula, and which being of less firm consistence than the calyptra is torn away with it.

The spiral ribs of the capsule are more deeply coloured, and are of firmer texture than the interstices between them.

Thus we have attempted to describe all the hitherto known British species of this well-marked and interesting genus; and we trust that in so doing, we shall have furnished work for some microscopes, and pleasure for their possessors.

OUR ATMOSPHERE AND THE ETHER OF SPACE.

In the Intellectual Observer, vol. ii. p. 408, we laid before our readers the views of M. Quetelet concerning the great probable height of our atmosphere, and its division into two parts, the lower one being the seat of much movement and agitation, the upper portion being extremely light, stable, and probably of different chemical composition. In *Cosmos* (18th Feb., 1864) we find the following report of remarks on this subject by Father Secchi the Roman astronomer:—

"The shooting stars observed at Rome years ago, with the aid of the telegraph, have given an approximative estimate of height of eighty kilomètres at the least.* That indicates a much greater height of the atmosphere than is ordinarily supposed. But what is the composition of this atmosphere? That is impossible to define. The phenomena of ordinary electricity carefully studied at the time of auroras may afford us some light. I am of opinion that the idea, which is beginning to be accepted, that auroras depend upon discharges of atmospheric electricity in elevated regions is correct, and if so it will be very interesting to determine the

* The kilomètre is rather more than six-tenths of a mile (0·6214).

height of this meteor as seen from neighbouring places, and using the telegraph as an aid."

Cosmos also gives a letter from M. Hansteen of Christiana, to M. Quetelet, in which he says:—"Your last article on shooting stars and their place of appearance, has particularly interested me, on account of the idea put forth by you and approved by Sir John Herschel, H. A. Newton, and Aug. de la Rive, that beyond the lower atmosphere in which we live—and which you call the unstable atmosphere—there exists a second atmosphere three times as high—and which you term the stable atmosphere—of different composition, much lighter, and therefore, so to say, more igneous. It is only in this latter atmosphere that auroras manifest their luminosity. The upper atmosphere in which auroras and shooting stars appear as luminous bodies, may be nothing else than a very rarified hydrogen, very light and very inflammable. The period of revolution of Encke's comet, which diminishes one-tenth of a day at each revolution, suggests the existence of a resisting medium, which is accounted for by supposing the presence of a certain ether, the nature of which is unknown. May not this ether be very rarified hydrogen diffused through space."

The suggestions of M. Hansteen, though interesting, are open to certain objections. Why does he imagine the upper atmosphere to consist of hydrogen? Is it simply because that is the lightest body we are acquainted with on the surface of our globe? There is no reason whatever to suppose that the lightest body we know must resemble in composition, or be identical with, any lighter body that may exist somewhere else under totally different conditions. Nor is there any reason for supposing that the inflammability of hydrogen would be augmented by enormous rarefaction.

When a body is called inflammable we should remember that the term is not very precise.

It is customary to speak of certain bodies as being either combustible, or supporters of combustion; but the following remarks of Professor Miller place this subject in a clear light and show how easily the terms become convertible. He tells us* that "a striking experiment may be performed with hydrogen, which shows how purely conventional are the terms 'combustible' and 'supporters of combustion.' Let a tall bottle with a narrow neck be filled with hydrogen gas; through a cork which passes easily into the neck of the bottle, fit a jet connected with a gas-holder containing oxygen; place the bottle mouth downwards and set fire to the hydrogen, then immediately insert the cork and jet through which a stream of

* *Elements of Chemistry*, Part II. p. 48. Second edition.

oxygen is gently issuing. The flame will appear to attach itself to the oxygen tube, and the jet of oxygen will be burning in an atmosphere of hydrogen. Combustion in fact occurs at the place where the two gases first came into contact. Suppose for a moment that the earth's atmosphere had contained hydrogen instead of oxygen; oxygen would have appeared to us in the light of a combustible gas; hydrogen in that of a supporter of combustion."

The term "more igneous" may not be intelligible without considering the sense in which Sir John Herschel employed it, in the letter to M. Quetelet, from which M. Hansteen adopted it. Sir John said, that the great elevation of shooting stars above the earth "leads to the conjecture of an upper aerial atmosphere, lighter and so to say more *igneous*." Mr. Alexander Herschel has provided us with some remarks on this subject. He observes, "that according to the calculations of Thompson and Joule a body moving with a velocity of thirty-nine miles per second will heat the air, of whatever density, in immediate contact with it, two million degrees. Surely such velocities are more likely to exist in the highest and thinnest strata of the atmosphere, than in the lower denser parts, where storms and clouds, etc., are prepared, and in this sense the upper atmosphere may be called the igneous atmosphere, because it is more exposed to such igneous catastrophes from which the lower strata is happily defended."

If we consider the effects of heat and pressure in modifying the condition of matter, it will appear probable that there are limits to the existence of compounds having definite properties, both in a pressure range and a temperature range —that is to say, that no compound could be heated, or cooled, beyond a certain point without its becoming decomposed, or having its particles re-arranged into a new substance. And also that no compound could be condensed, or rarified, beyond certain limits without undergoing decomposition or change.

The grounds for conceiving the earth's atmosphere to be only forty or fifty miles high were incomplete. It was supposed that at about that distance from the earth the elasticity of the air and the force of gravity balanced each other. M. Quetelet now shows reason for believing that an upper atmosphere exists, and he assigns to it a different composition. May it not result from a resolution of the earth's lower atmosphere into some other form of matter? Oxygen and nitrogen may be compound bodies, and may be decomposed under such remarkable conditions of temperature, pressure, etc. Even if we regard them as simple substances, we have no right to limit their capacity for existing under different conditions, and with very different properties. The difficulty of defining a species

extends to chemistry, and it is far from easy to say what constitutes oxygen, for example. In zoology the idea of hereditariness, or common descent, comes into the species idea; in chemistry identity of constitution and properties is sufficient. But is ozone identical in constitution with oxygen, of which it is called an allotropic form? If M. Soret is right* in affirming that it is composed of a plurality of oxygen atoms arranged in a particular way, we must be either prepared to regard it as another substance, or to deny that the mode in which atoms are aggregated and the special properties thus developed, give rise to different species of substances. It may be said that ozone is not after all sufficiently unlike oxygen to require a separate name; but what of antozone? Schönbein considers that when one portion of oxygen is converted into ozone another portion passes into the state of antozone, which differs in properties from ordinary oxygen and from ozone. Antozone and ozone he considers in opposite polar conditions, and that when they come together they neutralize each other and produce ordinary oxygen. If so they act like distinct and different substances, exhibiting an affinity for each other.

M. Hansteen's supposition that the ether, or fluid conceived to exist in space, is like the upper atmosphere of our earth is worth consideration; but if so, that upper atmosphere must be capable of the requisite attenuation without being changed into another substance. Is it not a more probable supposition that however slowly the process may take place, all the bodies that swim in space contribute to the space atmosphere or ether, which would thus be composed of the most volatile and attenuated forms the materials of the various globes can assume when their normal cohesive and affinity forces are diminished or over-balanced by repulsive forces or new affinities?

Does it not seem improbable that each globe should retain for ever all the particles that it started with? Is not a circulation of matter more consonant with analogy? Why should the space atmosphere not only be added to, but taken from? Can our sun and all other suns be burning, or condensing it? The enormous temperature usually assigned to the solar photosphere may dissociate ordinary compounds, and develope powerful affinities between photosphere matter and the space atmosphere, and if it condensed millions of cubic miles with sufficient velocity, enormous heat would be produced.

With reference to the ether, or space atmosphere, it may be observed that the quantity of matter which is contained in a given volume of it, *may* not afford any measure of its resistance to planetary motion. In a paper on molecular mechanics, by the Rev. Joseph Bayma, published in the *Proceedings of the*

* See INTELLECTUAL OBSERVER, vol. iv. p. 308.

Royal Society, No. 16, that gentleman affirms that "if a body does not contain any repulsive elements, it cannot cause any retardation in the movement of an impinging body;" and other reasons might be assigned to account for the small retardation of moving bodies without assuming a tenuity calculated from the known properties of atmospheric air.

Mr. Bayma's theory is not the only one that might account for the resistance offered by the space-atmosphere to a moving body, not being proportionate to the actual quantity of matter contained in a given bulk of it. What is called *vis inertia* is not, as we have remarked in another paper, simply do-nothingness, but the result of active forces, one of which is gravitation, and we have certainly no right to assume that gravitation is an attribute or property of matter under *all* conditions. It may be one of an unknown number of correlative forces, and the force which acts as gravitation under one set of conditions, may appear in another character when the conditions are changed.

These speculations may be dreams and nothing more; but a little dreaming is good for scientific progress, provided the process of dreaming is not vainly conceived to be a process of proof.

As our object in publishing these conjectures is to stimulate thought and inquiry, we will either print *in extenso*, or give an account of any important communications we may receive on any of the points discussed.

ANCHORING MOLLUSKS.

BY W. NEWTON MACCARTNEY,

Cor. Secretary Glasgow Naturalists' Society.

At the end of the last century the rage for conchology reached its climax, and then slowly declined. In its place the study of malacology engrossed the attention of many of those who had only gathered shells for the beauty of their form and the brightness of their colours. The possession of a cabinet of shells fifty years ago (and in many cases, even now) did not bestow upon the owner any knowledge of their structure or habits, and it was only when he gathered, observed, and dissected that he gained that essential knowledge which, while benefiting himself, would help the progress of the science. The shell to the conchologist may be of interest, but the animal which inhabits the shell will give a more enduring pleasure to the malacologist who studies its structure and observes its habits.

During the rage of shell-collecting, when a *Carinaria*

brought 100 guineas, and *Conus gloria-maris* half that sum, the parts of the animal which are the subject of this paper could not be studied, as, invariably before they were passed into the cabinet of the shell collector, they were cleaned from the specimen. However, in our times, when the animal is studied, as well as the shell admired, these organs by which the animal anchors itself may without difficulty be examined, and cannot fail to interest the observer.

The byssus of the mussel, and the pedicle of the lamp-shells, are considered to be of little, if any, importance in their study, and consequently not being much examined, some little things require to be explained, and some misapprehensions cleared away.

The importance of the cables in both these classes of mollusca, cannot be over-estimated by the palæontologist; for, in his explorations, he often disentombs large numbers of *brachiopoda* which have lived and died on the spot where he finds them. He is disposed to wonder why such quantities have gathered together, and it is only when he finds them to belong to the class of shells which anchor themselves to the sea-bottom that his amazement ceases. They can by means of their pedicle resist the scattering tendencies of the waves, and not being disturbed, the places where they have taken up their abode becomes densely populated, while spots not very far distant cannot boast a specimen. To the naturalists the knowledge of the mussel's habits sufficiently explain the colonies of them which occur in places suitable for their development.

During the geologic ages the lampshells, or *Terebratulidæ*, existed in great numbers, and in many cases the opening by which the pedicle protruded is distinctly visible. Then, as now, they attached themselves to rocks, stones, branches of corals, and every "coigne of vantage," and there hung freely suspended, swaying to and fro with the pulsations of the mighty ocean. In our still and deep lochs they are often brought up in the dredge, and if the locality is suitable, that is, of a calcareous silt, or muddy bottom, every small stone, or large shell, will have these little lampshells clinging to it. These shells are now but meagrely represented, when we consider the immense multitudes which swarmed in the seas during the deposition of the carboniferous limestone. There the sepulchres of countless thousands belonging to many species may be opened in every quarry.

The mussel, by means of its byssus, is able to remain secure on rocky coasts, where otherwise it would be dashed to pieces by the first rude storm. The fisherman, who uses them for bait, chooses a calm summer's day to place upon his new mussel farm the boat-load which he has forced to emigrate to "pastures

new." He knows that stormy weather would result in his emigrants being driven on shore; so he chooses his time, that the mussels may spin their cable and anchor securely. The owner of piers also requires to tend the crop of mussel carefully, so that they may cover the wooden piles, and thus protect them from the attacks of the boring shells. Some people think that they are useless on the wooden piers, and consequently scrape them off, considering that they destroy the piles, and eat into the wood.

Let it not be understood that the pedicle of the lampshell and the byssus of the mussel perform the same function. The pedicle, like the byssus, anchors the shell, but, unlike the byssus, assists the pedicle in closing and opening the shell. It is a fleshy cable, composed of fibres which are contractile. This cable is attached at one end to the stone by a kind of glutinous substance, and at the other to the upper or ventral valve. Within a little distance from the foramen, or little hole through which it passes into the shell, muscles are attached. These join on to the pedicle near to the point of emergence, and are also attached to the dorsal valve by the other end. The hinge of the shell is at the foramen. When the animal is at rest, and not disturbed, the pedicle is uncontracted, and the shell open. The cable being at its longest range, allows the shell to hang free, and to have a pretty wide range; but whenever danger approaches instantly the pedicle contracts, the shell by that action shuts, and at the same time darts backward a little towards its anchorage, out of the way of the intruder. The pedicle contracts, and the muscles which are attached to the pedicle contract at the same moment, and the shell is fast closed, to be opened when danger is past.

In the mussel the byssus acts no part similar to this. When once it is spun it is lifeless. The visitor to the seashore will find that it is made up of a great many small threads, which have taken a very firm hold. These are connected with the interior of the shell, and are extremely strong. The question suggests itself, how are these threads spun, and how do they fasten to the rock? The mussel has no spinnarets like the spider or the silkworm. That there is a sticky secretion no one can doubt; but of what it is composed, and how it is secreted, is yet to be discovered. A Glasgow naturalist has observed the process of placing the cable, which may be briefly described. The foot was protruded, fat and fleshy, and touching the side of a glass jar, it remained for a time in contact. After withdrawal nothing was noticed for a moment, but then slowly a little thread became visible, and the first thread of the cable was laid, which was followed by another, and another, as the foot touched the side of the glass. There must, we think,

be a secreting surface either in the foot or easy of access to it; and that secretion hardens and blackens by exposure to the water. The threads are attached to the shell, and have no connection with the internal economy of the animal. The byssus spun by the *Pinna* has been used with silk, and spun into some articles of dress. That of the great horse-mussel is exceedingly fine, and if it could be obtained in sufficient abundance might be used in commerce.

In conclusion, could not a series of experiments be made on the mussel (*Mytilus edulis*), to discover how it spins its cable, and where it gets the material? By discovering this, we could then with certainty understand how the Lima and other shells make their nest, for they also use silken fibres to bind the materials of which their house is built.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from page 384, vol. iv.*)

663. On September 27 a comet 2' long was seen near ζ Boötis. On September 29 it had disappeared.—(Ma-tuoan-lin.)

667. On May 24 a comet was seen in the N.E., between Auriga, the Pleiades, and Taurus.—(Gaubil.) On June 12 it disappeared.—(Ma-tuoan-lin.)

668. In May or June a comet was seen for a few days in Auriga.—(De Mailla, vi. 145.) Is it certain that this comet differs from the preceding?—(Pingré, i. 331.)

676. [i.] On January 4 a comet 5° long was discovered to the S. of α and ζ Virginis.—(Ma-tuoan-lin.)

676. [ii.] "In the month of August a comet showed itself in the E. for three months, from the time of cock-crowing till morning. Its rays penetrated the heavens; all nations beheld with admiration its rising; at length, returning upon itself, it disappeared."—(Anastas, *Historia Ecclesiastica;* Paul Diacon. v. 31.) On September 4 a comet appeared near to α and β Geminorum; it moved towards the N.E. Its tail, at first 3° long, afterwards increased to 30°, and pointed towards λ and μ Ursæ Majoris. On November 1 it had disappeared.—(Ma-tuoan-lin; Gaubil.)

681. On October 17 a comet 50° long was seen near *α* Herculis; gradually diminishing in size it moved towards *α* Aquilæ, and disappeared on November 3.—(Gaubil.)

683. On April 20 a comet was seen near *α* Aurigæ. On May 15 it had disappeared.—(Ma-tuoan-lin.)

684 [i.] On September 6 a comet 10° was seen long in the evening towards the W. On October 9 it had disappeared.—(Gaubil.) Hind remarks that this single account will tolerably well describe the position which *Halley's comet* must have been in at its return to perihelion in this year; so, doubtless, this was that celebrated body.—(*Comp. to Almanac,* 1860, p. 88.)

684 [ii.] On November 11 a star like a half-moon was seen in the N.—Ma-tuoan-lin.

707. On November 16 a comet appeared in the W.; on December 18 it had ceased to be visible.—(Ma-tuoan-lin.)

708. [i.] On March 31 a comet appeared between the Pleiades and Musca.—(Ma-tuoan-lin.)

708. [ii.] On September 21 a comet appeared within the circle of perpetual apparition.—(Ma-tuoan-lin.)

711. In the 92nd year of the Hegira a comet endued with a sensible motion appeared for eleven days.—(Haly. *Liber Ptolemæi Comment.*) The year 92 of the Hegira lasted from 710, Oct. 29, to 711, Oct. 18.

712. In August a comet emerged from the W., and passed to near *β* Leonis, etc.—(De Mailla, vi. 199.)

716. A comet of a terrible aspect, with its tail directed towards the Pole, is said to been seen this year, but we have only a modern authority for the statement.—(Sabellicus, *Omnia Opera,* Ennead. viii. lib. vii., Basileæ, 1560.)

729. Several writers speak of two comets visible for fourteen days in the month of January, the one after sunset and the other before sunrise.—(Bede, *Historia Ecclesiastica,* v.; Herveld, *Chronicon Historiæ Germanicæ.*) It is easy to see that a single comet with a Right Ascension not differing much from that of the Sun, but with a high North Declination, would be seen both after sunset and before sunrise, and thus fulfil the statement of the chroniclers. Donati's great comet of 1858 was so visible for several weeks in the month of September of that year.

730. On August 29 a comet was seen in Auriga; on September 7 it spread its light over the Hyades and Pleiades.—(Gaubil.) Ma-tuoan-lin says that the comet of September 7 was not the same as that of August 29.

738. On April 1 a comet was seen within the circle of perpetual apparition. It traversed the square of Ursa Major, and was observed for ten days or more, when clouds interfered.—(Ma-tuoan-lin.)

744. A great comet was seen in Syria.—(Theophanes, p. 353.)

762. A comet was seen in the E. like unto a beam.—(Theophanes, p. 363.)

767. On January 22 a comet 1° long was seen near α and β Delphini. It was visible for three weeks.—(Ma-tuoan-lin.)

773. On January 17 a great star appeared below the belt of Orion.—(Ma-tuoan-lin.)

813. "On August 4 a comet was seen, which resembled two moons joined together; they separated, and having taken different forms, at length appeared like a man without a head."—(Theophanes, p. 423.) In spite of the strangeness of this description, Pingré considers it to be really that of a comet, and thinks it is possible to find an explanation in the comet's peculiar position with regard to the Sun and the Earth.—(*Comèt.* i. 338.)

815. In April or May a great comet appeared in the vicinity of β Leonis.—(Ma-tuoan-lin.)

817. On February 5, at the second hour of the night, a monstrous comet was seen in Sagittarius.—(*Vita Ludovici Pii.*) On February 17 the comet was in the Hyades.—(Ma-tuoan-lin.)

821 [i.] On February 27 a comet was seen in Crater. On March 7 it was near σ Leonis.—(Ma-tuoan-lin.)

821 [ii.] In July a comet with a tail 10° long was seen in the Pleiades. After ten days it disappeared.—(Ma-tuoan-lin.)

828. On September 3 a comet with a tail 2° long was seen near η Boötis.—(Ma-tuoan-lin.)

834. On October 9 a comet with a tail 10° long was seen near β Leonis. It went northwards beyond Coma Berenicis. On September 7 it had disappeared.—(Ma-tuoan-lin.)

837 [ii.] On September 10 a comet was seen in Aquarius.—(Ma-tuoan-lin; Boëthius, *Scotorum Historia,* x.)

838 [i.] On November 11 a comet was seen near β Corvi.—(Ma-tuoan-lin.)

838 [ii.] On November 21 a comet was seen in the E. in the sidereal divisions γ Sagittarius, and μ^2 Scorpio. It extended in the heavens E. and W.; on December 28 it had disappeared.—(Ma-tuoan-lin.)

839 [i.] On January 1 a comet was seen in Aries.—(*Annales Francorum Fuldenses.*) On February 7 a comet was seen near χ Aquarii.—(Ma-tuoan-lin.) Pingré thinks the latter could not have been the European comet of January 1.—(*Comèt.* i. 614.)

839 [ii.] On March 12 a comet was seen to the N. of ν, ϵ, ξ, ζ Persei. On April 14 it had disappeared.—(Ma-tuoan-lin.)

840 [i.] On March 20 a comet was seen between the sidereal divisions of α and γ Pegasi. After three weeks it disappeared.—(Ma-tuoan-lin.)

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

STATISTICAL SOCIETY.—*Feb.* 16.

Effects of Open-air Exercise on Longevity.—In a very elaborate paper on the reports of the Registrar-General, Mr. Sargant brought forward some remarkable facts, showing the influence of outdoor occupation and exercise in lessening the rate of mortality; and that of almost all in-door occupations, long continued, in raising the rate of mortality of the classes following them.

The greater longevity of persons living in the country appears almost wholly due to the greater proportion of out-door occupation; inasmuch as shopkeepers and others following sedentary pursuits in the country have no well-marked vital superiority over the same classes in towns; whereas farm labourers, though exposed to the effects of wet, attain a greater longevity than any class of mechanics working in a confined atmosphere.

Even scavengers in towns, who are exposed to very great impurities, are long-lived, owing to the vital influence of the open air in which they follow their occupation.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.—*Feb.* 23.

Preparation of Calcium.—A paper was communicated by Mr. E. Sonstadt on the preparation of the metal Calcium. After describing the well-known difficulties which have hitherto prevented calcium being prepared except in very small quantity, Mr. Sonstadt described his new process, which consists in fusing together iodide of potassium and chloride of calcium. The mixture, whilst still liquid, is poured into an iron crucible and permitted to solidify. The mass is then thrown out, and rather less than an equivalent proportion of sodium placed in the bottom of the crucible; the solid mixture of potassium and calcium salts being replaced above it. The cover is then closely luted on, and the crucible heated to redness for a short time. The reaction that ensues is not violent, and the calcium remains in the crucible in a solid mass.

At the same meeting the practical advantage arising from the improvements of Mr. Sonstadt in the manufacture of the metal Magnesium were shown. Ten grains of magnesium wire were burnt, giving a light which lasted for one minute, during which time an

excellent negative photograph of a bust by Chantrey was taken by Mr. Brothers.

The photographs produced by magnesium light are of a very agreeable character; and as the amount of metal required is very small, the process is not expensive, and it is probable that it may come into general use.

GEOLOGICAL SOCIETY OF LONDON.—*Feb.* 19.

Succession of British Mesozoic Strata.—The President in his anniversary address discussed the breaks in the succession of the British Mesozoic Strata. First, he examined the numerical relations which different classes bore to one another in Palæozoic times, comparing them with their development in secondary epochs. The general conclusion arrived at was that a long interval of time, often stratigraphically unrepresented, is an invariable accompaniment of a break in the succession of species; and the more special inference was that, in cases of superposition, in proportion as the species are more or less continuous, that is to say, as the break in life is partial or complete, first in the species, but more importantly in the loss of old and the appearance of new genera, so was the interval of time shorter or longer that elapsed between the close of the lower and the commencement of the upper formation.

Feb. 24.

Recent Discoveries of Flint Implements in Drift Deposits in Hants and Wilts.—Flint implements having recently been found on the sea-shore, about midway between Southampton and Gosport, and also at Fisherton near Salisbury, Mr. J. Evans visited these localities in company with Mr. Prestwich, and gave the results of his observations.

After describing the implements from near Southampton, and having shown that their condition is identical with that of the materials composing the gravel capping the adjacent cliff, Mr. Evans maintained the great antiquity of these remains, as proved by the circumstance that the gravel-beds, like those of Reculver, are of fluviatile origin, although now abutting on the sea.

Mr. Evans then described the Fisherton implements, and the gravel-pits from which they were obtained. The relation of the high-level gravels (in which the implements were found) to the lower-level gravels of the Valley of the Avon was discussed, and the geological features of the former deposits particularly described; lists of the fossils (including the mammalia and the land and freshwater shells) being also given. Mr. Evans came to the conclusion that the fossils bore evidence of the climate, at the time when they were deposited, having been more rigorous, at any rate in the winter, than it now is; and to this cause he attributed the comparatively greater excavating power of the early Post-pliocene rivers.

March 9.

On the Discovery of the Scales of Pteraspis.—Mr. E. R. Lankester communicated a paper on the Pteraspis, in which the suc-

cessive steps by which the genus was established, and the grounds on which the prevalent opinion as to its ichthyic nature rests, were noticed. The author then proceeded to describe the scales, which have lately being discovered at Cradley, near Malvern, and which alone were required to remove all doubt as to the affinities of the genus: he compared these scales with those of *Cephalaspis*, to some of which they bear a great resemblance.

ANTHROPOLOGICAL SOCIETY.—*March* 1.

The Theory of Natural Selection as applied to the Human Races.—In a paper on this subject Mr. Wallace maintained that the theory of natural selection, as influenced by physical structure, could not be applied to explain the origin of the different races of men in the same manner as it could be employed to account for the origin of varieties and species in the lower animals.

In animals a deficiency of any one organ or faculty would of necessity lead to the destruction of the race in the struggle for life. But in man any such deficiency may be supplied by means of the division of labour, by which an individual unfitted for one occupation could follow another; and also by the assistance and sympathy which always existed even in the lowest races of mankind. Moreover, by the formation and use of artificial weapons mankind can compensate for any deficiency in strength or agility.

These causes acting conjointly remove man from the influence of "natural selection," as far as regards his physical structure; but its action is transferred to the mind. Those races with the highest intellectual endowments, capable of the greatest amount of organization, and the fabrication of the most efficient arms, would of necessity overcome and eventually extirpate the inferior races. Hence it was argued that the possession of an intelligent mind removed mankind from the operation of the laws of natural selection; consequently his physical structure remained unchanged, except as far as regards slight and accidental variations.

It was shown that this theory harmonized many of the hitherto conflicting views of anthropologists, by demonstrating why races have so long remained unchanged, and are apparently unchangeable. At the same time, it offers no opposition to the generally received opinion of the unity of the human race.

ROYAL INSTITUTION.—*March* 4.

The Discrimination of Organic Bodies by their Optical Properties.—In a lecture on the detection of organic bodies by means of their spectra, Prof. Stokes showed an exceedingly simple and practical mode of distinguishing between substances of similar appearance. The solution of the body to be examined is placed in a test-tube, behind a slit in a small opaque board; light is allowed to pass through the tube, which is looked at with a small prism, used with the naked eye, when the characteristic appearance of the substance

is at once evident. In this manner solutions of blood and of port wine of equal intensity of colour are capable of being instantly distinguished from each other.

Prof. Stokes has applied this test to the green colouring matter of the bile, supposed by Berzelius to be identical with chlorophyll, and has discovered that it is perfectly distinct. Chlorophyll yields solutions in alcohol, ether, etc., which are characterized by very strongly marked bands of absorption, that are wholly absent in the solutions of the colouring matter of the bile, which has been named Biliverdin. There is no doubt but that the easy and practical mode of discrimination designed by Prof. Stokes will be of very great value to the working chemist and medical jurist in the distinction of organic substances of nearly similar appearance.

ARCHÆOLOGICAL INSTITUTE.—*March* 4.

ANCIENT HABITATIONS IN ANGLESEA.—The Honourable W. O. Stanley communicated a very interesting account of the remarkable circular habitations found in Anglesea, being particularly abundant in the neighbourhood of Holyhead. These habitations, which are usually from 15 to 20 feet in diameter, are designated as *Cuttier Gwyddelod*, or the Irishmen's huts, in the maps of the Ordnance Survey; there appears, however, but little doubt that the title is an erroneous one.

Each habitation is formed of turf, with two stones forming the sides of the entrance; these are often found standing in the erect position. A detailed description was given of the opening by Mr. Stanley and Mr. Albert Way of a village consisting of upwards of one hundred houses, standing on a terrace about six hundred yards in length from north-east to south-west. On this terrace the houses were placed close together, but without any regularity or plan, except that the openings were almost always turned towards the south-east.

A very early age was assigned to these dwellings by the author of the paper, who regarded them as having being constructed before the use of iron or other metals was known in the locality. He thought therefore that they must have been erected by the aborigines long before the invasion of the Romans; and not, as their popular name implies, by immigrants from Ireland.

Mr. Morgan stated that dwellings of a precisely similar character existed in Monmouthshire, which certainly were not the work of Irish invaders.

NOTES AND MEMORANDA.

Germs of Infusoria.—M. le Vicomte Gaston d'Auvray has addressed a letter to the French Academy, stating that by means of an apparatus, which he calls a *dialyser*, he filters water or other liquid so as to separate and collect the germs of Infusoria. He finds two sorts of germs, greenish grey and pearly white. He says they exist in all water, even when distilled, although most plentiful in that which is impure. In air he also finds them, and they abounded in the thick fog of 2nd of December, 1863. All the grey germs are spherical, varying in diameter from $0^{mm}.00024$ and $0^{mm},00034$. The pearl white corpuscles are of three sorts: A and B spherical, their diameter being $0^{mm},00040$ and $0^{mm},00065$; C are ovoid, with lesser axis, $0^{mm},00065$, and major axis $0^{mm},00080$. The grey corpuscles he calls germs of protophytes; the white, of animalcules, among which he includes vibrions. If the corpuscles are all removed from water, but the debris of organic matter, such as bits of textile fabrics, vegetable epiderm, pollen grains, butterfly scales, smoke particles, allowed to remain in a flask which is sealed hermetically, no life is developed, and the result is negative if some white of the white corpuscles are added. If however some of the greenish grey corpuscles are added, first protophytes, then amœbæ, monads, and vibrions appear. If into these flasks containing the grey corpuscles, the white ones, A, B, and C are added, A yields amœbæ, B monads, and C vibrions. M. d'Auvray states that he is preparing a work on this subject, and when the details are known his experiments can be checked by other observers. One of his most remarkable statements that demand verification, that some germs are able to withstand strong acids, prolonged boiling, or attempts at calcination, by passing the air containing them through red hot tubes.

Collins' Binocular Microscope.—This is a large, handsome instrument, presenting some novel and ingenious peculiarities. It carries two object-glasses on a dovetailed arm, sliding in a groove, so that a change of powers can be instantly made. We should think this mode of construction would require even greater attention to accuracy than the ordinary double nose-piece; but, if accurately centered, it affords certain advantages. The next important speciality is the facility with which the polarizer (carried under the stage) can be brought into play, and the analyser made to replace the prism of the binocular arrangement, by drawing in or out the slide which carries both. In certain chemical and medical investigations, these arrangements are very convenient, and several eminent members of the medical profession have expressed great satisfaction with Mr. Collins' labours.

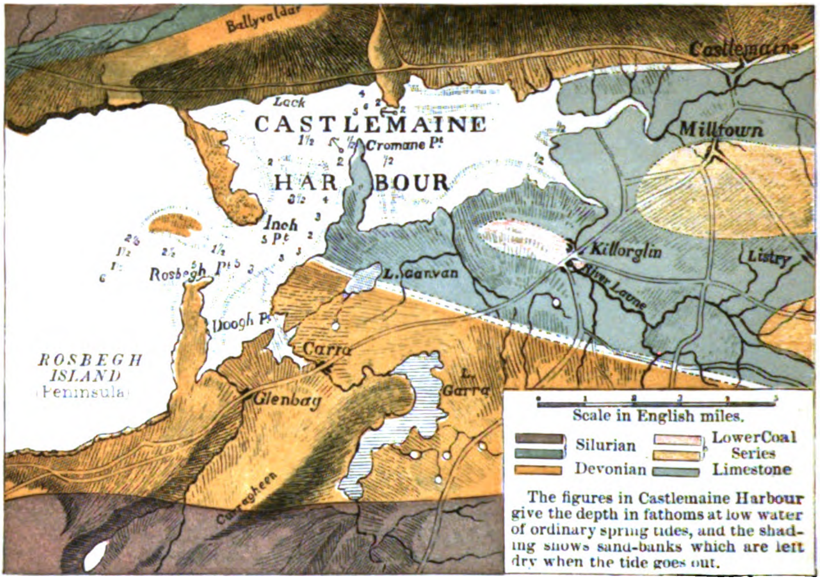
The stage is furnished with a magnetic bar, and if likewise supplied with the ordinary object-holder and clip, its range of utility would be increased, as the magnetic plan, though good for slides, is not well adapted for heavier articles like zoophyte troughs. We carefully examined the optical part of one of these instruments and found it fully equal to all ordinary requirements. Mr. Collins has taken an honourable place amongst those opticians who offer students a great deal of convenience for a small sum of money. In first-rate, costly instruments all kinds of wants are provided for; but where price is an object, the purchaser must consider what he stands most in need of, and what he can best dispense with. Under such circumstances tastes and necessities will lead to much difference of opinion, but it would be admitted on all sides, that Mr. Collins' binocular is well entitled to consideration, and likely to meet the wishes of a large class.

New Source of Potash.—A coral-red subtranslucent mineral, reported to have been obtained from Cheshire, has been submitted to analysis by Professor Church. He has identified it with the carnallite of M. H. Rose; it contained 25·7 per cent. of chloride of potassium. It is most probable that this rich source of potash overlies the rock-salt beds of this country as well as those of the foreign localities where carnallite has been found. It has been suggested that it was formed in the *last* stages of the drying up of ancient seas.

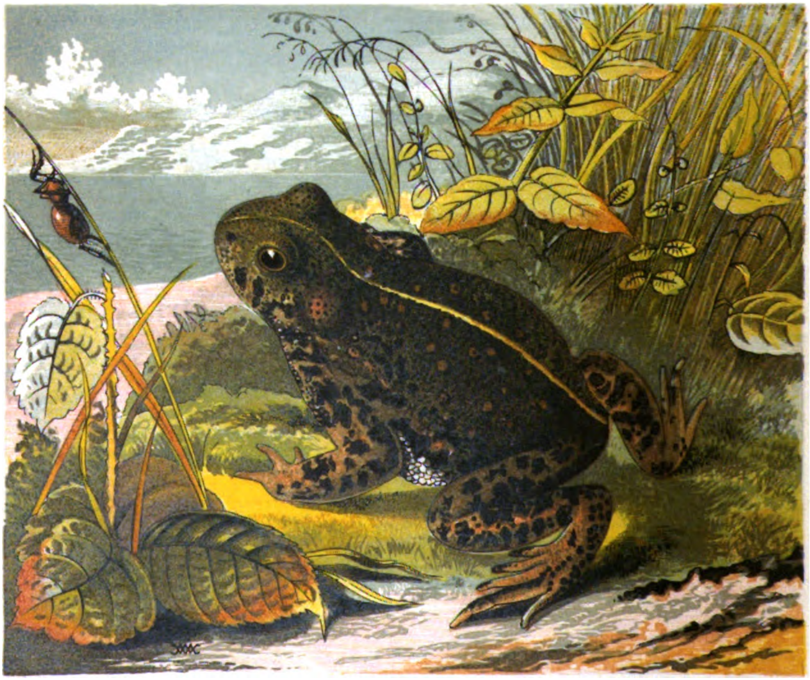
Permeability of Metals at High Temperatures.—M. L. Cailletet has made the following communication to the French Academy. After remarking upon the facts mentioned by MM. H. St. Claire Deville and Troost, who found that iron at a high temperature was completely permeable for oxygen, and that a tube, heated in a furnace, and filled with hydrogen, allowed that gas to escape so that a vacuum was formed, M. Cailletet proceeds to detail his own experiments. He says—"I passed portions of a gun-barrel through rollers till they were flattened. The ends were then welded (*soudées*). Thus rectangular pieces of iron were obtained, formed of two plates in contact, and sealed at their extremities. On strongly heating one of these pieces in a furnace, the non-welded portions separated, and resumed the cylindrical form and their original volume. It could not, therefore, be doubted that the gases of the furnace had penetrated the mass of iron and distended its walls." To a similar action Mr. Cailletet ascribes the cavities in large masses of forged iron; and he states that in the process of cementation, *acier poule*, or steel with vesicles, is constantly produced; but if soft, perferfectly homogeneous iron, such as can be obtained by keeping melted steel for several hours at a high temperature, be employed, it is reconverted into steel without blisters. M. H. St. Claire Deville remarks upon this communication that it is "very interesting and conclusive," and he adverts to the discharge of gas from molten matter often observed in metallurgical operations. These gases, he considers, penetrate the walls of the crucibles by endosmose, and give rise to bubbles in the metals.

Action of Porcelain and Lavas at High Temperatures on Gases—Possible Action of the Moon.—M. Ch. St. Claire Deville makes allusion to the preceding facts, and states that his brother and M. Troost have shown that if hydrogen traverses without difficulty the walls of a porcelain tube at a high temperature, it does not do so when the tube begins to soften or vitrify. The gas is then absorbed by the vitrified surface, from whence it escapes, leaving it porous. He connects these facts with the appearance of certain lavas. He says the lavas of Vesuvius, whatever the rate of their cooling, are always crystalline, and that they disengage aqueous vapour, chlorides, sulphides, etc., as the crystallization proceeds, just as oxygen escapes from silver that takes the rocky form, or air escapes from freezing water. The crystallization of lavas he states to be accompanied by increase of density and evolution of heat. He traces a resemblance between the Campi Phlegræi and the surface of the moon, and considers that the latter may have behaved like eruptive matter with excess of silica, which has a tendency to consolidate in a vitreous form, and imprisons gaseous matter in its solidification.

M. Vial's Process of Engraving.—The lines are drawn on steel with a fatty ink, or transferred to the steel, which is then plunged in a bath, saturated with sulphate of copper, and accidulated with nitric acid. In five minutes the plate is removed and washed; the copper is removed with ammonia, and the engraving is finished. The explanation is that the metallic solution deposits copper on those parts of the plate which are not covered with ink. This copper is removed by the final washing. The acid penetrates the ink slowly, and when this is accomplished a galvanic circuit is completed between the deposited copper and the steel, protected by the ink from the simple deposition. The steel becomes the positive pole, and is attacked by the sulphuric acid liberated from the copper by the free nitric acid. M. Vial states that this action is strongest where the ink is thickest, and that lines are thus etched of the proper depth and thickness. The copper that results from the electro-chemical decomposition is said to be thrown down on the borders of the lines, and to lift up the ink so as to form the pattern in raised copper, which is removed by the ammonia. The process was favourably reported on by a Commission of the French Academy; and when recently exhibited at the Society of Arts, some practical engravers present thought it would be adapted to the cheap and convenient reproduction of effects not requiring the aid of shading in cross lines.



Map of a small portion of the County of Kerry, showing the district in which the Natterjack Toad is found indigenous.



Natterjack Toad (Bufo Calamita) from Co. Kerry.

THE INTELLECTUAL OBSERVER.

MAY, 18[illegible].

THE NATURE OF [illegible]

BY [illegible]

[illegible]

[illegible] to present [illegible] which has [illegible] knowledge [illegible] it in various [illegible]

[illegible] appeared in [illegible] daily newspaper, [illegible] on October 31st, 18[illegible] [illegible] It stated that the [illegible] [illegible] of [illegible] [illegible] Kerry. [illegible]

[illegible]

[illegible] Kerry." [illegible]

[illegible]

THE INTELLECTUAL OBSERVER.

MAY, 1864.

THE NATTERJACK TOAD IN IRELAND.

BY THE HON. MRS. WARD.

(*With a Coloured Plate.*)

MY object in the following remarks on the Natterjack Toad in Ireland is to present to the reader, in a tangible form, a little information which has apparently remained latent for a long time, not reaching the general public, so far as I am aware, and certainly not becoming known to myself till about a year ago, when I learned it in various accidental ways.

A paragraph appeared in a Dublin daily newspaper, the *Irish Times*, on October 1st, 1862, headed "Irish Toads and their use." It stated that the rarer British toad (*Bufo calamita*) is an inhabitant of certain districts in the county of Kerry. "These Irish toads," continued the writer, "are very pretty creatures, utterly devoid of that cold slime and general ugliness which render frogs an object of aversion. They are quiet little beings, and are readily tamed;" and it was added that they would be found very useful in a greenhouse, being expert destroyers of *aphides* and other insects. I did not agree with the writer's denunciation of the frogs; but I was greatly interested in the statement about the natterjack toad being found in Ireland, as it tended to confirm an anecdote which I had heard in England two months previously. I wrote to ask the editor on what authority the existence of *Bufo calamita* in Kerry was stated.

In reply I was referred to the work of Dr. Charles A. Cameron, M.R.I.A., a *Guide to the Royal Zoological Gardens, Phœnix Park*,* where, at p. 46, I read, "The common toad, (*Bufo vulgaris*) is a native of England, but is never met with in Ireland, its place being occupied by the natterjack toad (*Bufo calamita*), which, however, is exceedingly rare, and confined to the county of Kerry." The proprietor of the *Irish Times*

* M'Glashan and Gill, Dublin, 1861.

(Capt. L. Knox) not only presented me a copy of Dr. Cameron's little work containing this information, but, to give me still more substantial evidence on the subject, most obligingly obtained for me a live natterjack toad caught in Kerry. It arrived quite safely in the midst of some moss in a pasteboard box, on October 11th, and thenceforward, till it went some inches underground in November for its winter sleep, it was a pet and favourite in our house. I readily agreed with the *Irish Times* writer's opinion, that it was a "very pretty creature," and appreciated its superiority to the frog; it ran in a brisk, pleasant way, with its body well raised from the ground, and no doubt this might, by most observers, be preferred to the alarming jump of a frog; and its beautiful deer-like eye could not fail to be admired. My drawing, from which the coloured plate is engraved, correctly represents its size, form, and markings, and is taken as it appeared when animated by the sight of a fly or spider. I was told that it could be very easily tamed, and that some toads of this species would run across a table and take a fly from the hand of a person they knew. I could imagine that mine had probably done this, for it seemed very well to understand being fed, and though it would not eat from my hand, it readily walked up to any flies which I placed near it; it would "point" a fly, exactly in the manner of a trained dog pointing a covey of partridges—then it would perhaps make one stealthy step nearer—then the insect would disappear! swallowed by the toad, which caught it with its tongue, as the books inform me; for the utmost I could see, even with close attention, was a sort of red flash about its mouth, but after this, if the fly or spider was large, my toad's head would become, in an extraordinary manner, confused in its outline, its eyes closing, and appearing to sink to a lower level till the work of swallowing was over.

I kept this toad for a while in a common box, with a little lace, or, strictly speaking, "net," stretched over an opening cut to admit air, and with plenty of damp moss inside; but at my leisure I converted a hand-frame from the garden into a "vivarium" for it, furnishing it with some turf and heather, and fastening two pieces of net over the vacant places where two panes of glass had been broken.

The marked success of my inquiries so far, encouraged me to ask more questions, and I proceed to relate the facts which were elicited.

The exact place in Kerry where the natterjack toads exist is around the harbour of Castlemaine, situated at the eastern extremity of Dingle Bay, which (as any map of Ireland, even the outline ones which accompany Railway Guides, will show) is the northern of four or five deeply recessed inlets on the west

coasts of Kerry and Cork. Two headlands will be discerned, nearly facing each other, and forming the division between Dingle Bay and Castlemaine harbour; these are Inch Point and Rosbegh Point, and will frequently be mentioned in this narrative.

The circumstance of the existence of these little reptiles in this district appears to have been first publicly detailed at a meeting of the Dublin Natural History Society on November 5th, 1841, by William Andrews, Esq., president of the society. On that occasion Mr. Andrews presented to the society four specimens of the natterjack toad, and three rock-pigeons, all which he had secured during a ramble taken by him in the county of Kerry during the month of August in that year. He accompanied these gifts with a most interesting lecture, describing the various plants and animals which he had met, in a manner calculated to stir the heart of a naturalist. The report of this lecture is before me; it is contained in a copy of *Saunders's News-Letter* for Tuesday, November 9th, 1841; and Mr. Andrews informs me that the transactions of the society were not otherwise published at that time, which, he says, "may account for the discovery not being mentioned in books of British reptiles."

I will quote his account of the toads at full length—it occurs after his description of the productions and scenery of Brandon Mountain, Ferriter's Cove, the Blasquet Islands, and Cahir-Conree. "Rosbegh Island," he says, "which forms the south-eastern terminus of Dingle Bay, was next the scene of my rambling. There grows the rare and beautiful *Lathyrus maritimus* (*a* of Graham, in Hooker) the only now known locality in Ireland. Several sheltered mounds of sand are completely surrounded and covered by the dense foliage, and enlivened by the purplish-crimson flowers of this handsome plant. Its roots are remarkably strong, and, not penetrating to any depth in the sand, can be traced creeping to the extent of twenty feet. Luxuriating beneath the shade of their broad and thickly-set leaves, the natterjack toad (*Bufo calamita*) reposed. These little animals (inhabitants of heaths and commons in the southern parts of England, and on the coasts of the Solway Frith) abound in the Island of Rosbegh, and also in Inch. They have the thick and squat body, covered with tubercles, the characteristic of toads, with the porous swelling behind each eye, yet they do not express the fetid secretion of *Bufo vulgaris*. The stealthy yet animated action they evince in setting their prey is exceedingly amusing. In their quiescent state their colour appears of a dull olive brown, but when excited their eyes largely dilate, displaying the bright gilding of the irides, and their markings become of a lively yellow, the mesial

stripe along the back appearing more strongly conspicuous. Flies, grasshoppers, beetles, and the larvæ of insects are their general food, which they take (only when the object is in motion) by darting their tongue with astonishing rapidity and precision. Their note is a pleasing chirp; but in the breeding season at night they keep a continued and confused noise, like to the action of a number of spinning-wheels. Strangers that visit Rosbegh during the bathing season do not like occupying the cottages near to the beach, being alarmed at the nightly pranks of these lively but harmless little creatures.* The peasantry have the greatest horror and even dread of them, and on my expressing my astonishment (at the Dingle side) at the number of those reptiles congregated about Rosbegh, was readily answered [in Irish]—

> "Wild Iveragh of the blue dragons,
> Glencar, in which no corn ever grew,
> And the high and horrid hills to the west of Desmond,
> All which Saint Patrick never thought worth blessing.

"It appears that Saint Patrick in all his visitations through Ireland, never blessed Iveragh with his presence, his nearest approach being to a bridge east of that district, not far from Killorglin. The Iveragh people console themselves by saying that the Saint, standing on the bridge, stretched forth his arms to them exclaiming—

> 'I bless ye to the west of me, and it is as well as if I travelled through.'"

Iveragh, I should explain, is a barony in the county of Kerry, situate immediately to the west of Glanbehy and the mountain of Curragheen, and including the peninsula, or, as it is usually styled, the *island* of Rosbegh, which, as Mr. Andrews states, "was formerly separated from the mainland; but Lord Headley's extensive improvements have converted marshes and sands, that the tide once widely covered, into rich pastures where hundreds of cattle now graze."

At the close of his lecture, Mr. Andrews said that he had received the utmost kindness and attention from the coastguard officers at Dingle and Ferriter's Cove, as well as from the men of the coastguard generally in that district; and this remark leads me to the other pieces of information which I possess, and for which I am indebted to one of the last mentioned officers, Mr. Ross Townsend, now residing at Balbriggan.

Soon after I had received the information conveyed in the old copy of *Saunders's News-Letter*, I happened (craftily) to ask a distinguished Irishman, "Are there any toads in Ireland?"

* I am told by Mr. Andrews that the natterjacks astonished these strangers not only by their whirring noise, but also by actually entering the ground-floors of the cottages, and climbing over the furniture.

"Oh! surely not," he answered, but on reflection added, "by the bye, there must be, for I have seen a whole boat's crew of them." He directed me to a place where I might hear of them, and after some inquiries I made them out in Dublin at No. 20, Molesworth Street.

What a sight, to be sure, with the subject of the natterjack toad in my thoughts! There I saw no less than forty-five of these creatures, cleverly stuffed, mounted in a case containing a well modelled sea, with boats and background; the toads being employed as the *dramatis personæ* in a species of marine entertainment or regatta. I confess to having felt a qualm of sorrow at first seeing them, similar to that with which the "Wurtemburg animals" inspired me in 1851, and especially the comic frogs, which seemed to me to quote Esop, and say, "It is sport to you, but it is death to us," while I felt inclined to answer, "It is *not* sport to me; I like you better alive and well;" but this feeling got over, how interesting to observe the peculiar "mesial stripe" of the natterjack, displayed on every broad back; and how forcibly the abundance in which these creatures are found is set forth by the numbers here congregated, varying from about half-an-inch in breadth to dimensions surpassing those of a full-grown frog. The group belongs to Sir James Dombrain, and the toads, as I afterwards ascertained, were prepared by Mr. Ross Townsend, who rightly judged that this mode of presenting them to view was likely to attract notice to the fact of their occurrence in Ireland.

One of my friends kindly wrote to him, at my request, for some information; this he gave fully in reply, and I shall presently transcribe it from his letters. I have prepared the little map (see coloured plate) especially to illustrate Mr. Townsend's remarks. It is taken from the "General Map of Ireland [scale four miles to an inch] to accompany the report of the Railway Commissioners, showing the principal physical features and geological structure of the country." These particulars, even to the depth of the water in and near Castlemaine harbour, I have copied with a view of presenting as much as possible to the eye.

"You will perceive," writes Mr. Townsend," that the harbour [of Castlemaine] is formed inside the bar by Rosbegh Point on the south side, and by Inch Point on the north. In the circle of this harbour, from Inch Point on the north, round to Rosbegh Point on the south, passing Lack, Castlemaine, Milltown, Killorglin and Cromane, in all these places toads are to be found in great abundance. The soil is generally of a light turf mould, or sand marsh; in both of these they delight to keep, as the soil is easily penetrated, and they can get covering for themselves in the winter." Mr. Townsend goes

on to say, that Mr. Andrews in his ramble in Kerry had spent some time with him at Lack and Killorglin. "In one of our excursions," he continues, "on a salt marsh on Rosbegh Point, we found the first toad [the place marked by a *red dot* on my map]—at least the first which was known to be such in that part of the country. Mr. Andrews told me that the late Mr. Thompson of Belfast, who was a naturalist of great research, had mentioned the existence of toads in Kerry as far back as 1805; but the best informed of the people of Kerry at the time I speak of—1841*—did not know of their existence, as the country people called them 'Black frogs.'

"The species I am now describing is the natterjack toad; you will see its specific character, as known in England, described fully in Bell's *History of British Reptiles*, published in 1849; but Mr. Bell was not then aware of this species being found in Ireland. The natterjack toad is never found in those localities I have mentioned more than a quarter of a mile from the sea-shore; but all round the harbour of Castlemaine, which you may see is of considerable extent, they are exceedingly numerous, and from the month of April until September they could be gathered in dozens, as they go forth creeping, or rather running from one locality to another; they make a whirring noise during the evening and night, when some thousands of throats are employed at once, and which I have heard on a calm night more than two miles at sea." Mr. Townsend adds, that on one occasion he removed a few dozens of them to a coastguard station, north-east of Dingle, that is to say, some miles west of Inch Point, and though he remained there twelve months, he never could trace one of them, although the soil he selected for them was exactly like that from which he took them.

The simultaneous disappearance and power of concealment exemplified by these toads, correspond closely with some anecdotes given by Mr. Couch in the INTELLECTUAL OBSERVER for September, 1863; and their aptitude for escaping, which Mr. Couch narrates, was proved, I much regret to say, by the little natterjack whose likeness heads this article. It buried itself in November in a mixture of sand and peat (or as we say, turf-mould) which I had carefully prepared for it in a wooden box, over which the hand-frame was placed, the corners of the box being, as I thought, securely stuffed with moss, wedged down with pieces of slate. Nevertheless it escaped; for when its non-appearance in spring caused me to make a regular search for it, first in the box, and then in the whole room, I had the vexation of finding it dead and dried to a mummy in a distant corner.

* 1840 in Mr. Townsend's letter; but the newspaper appears to fix the date in the following year.

The desire for escaping appears to be a constant habitude of the natterjack, and its powers both of burrowing and climbing cause it to rival Baron Trenck in the success of its endeavours. Mr. Andrews kept some specimens for years in his garden at Rathmines, near Dublin, and has observed that nothing but high walls, with deeply laid foundations, will avail to secure them. Three or four natterjacks will assist three or four more to climb by generously allowing their shoulders to be used as ladders: these creatures piling themselves one on another, like Chinese tumblers, and actively holding on to the smallest inequalities of the wall.

Mr. Townsend concludes his letter by repeating the legendary story of St. Patrick, which he gives to nearly the same effect as Mr. Andrews did, adding, however, that the persons who told it to him had no idea that toads inhabited their neighbourhood. But, surely, we need not complain of the exceptions which present themselves to the non-existence of reptiles in this Green Isle. If the word of promise in this matter be broken to the ear, surely it is fulfilled to the hope; we have no colony of snakes, no lurking adders, although we now and then meet with the sand lizard; are plentifully supplied with the frog and smooth-newt, and possess in Kerry—and possibly elsewhere in Ireland—an isolated party of the harmless NATTERJACK TOAD.

PHOTOGRAPHIC PROCESSES.*

BY J. W. M'GAULEY.

IT is not our purpose to enter into the minor details of photography; we shall content ourselves with noticing the characteristic features of the various processes, remarking, once for all, that each of them may be modified in a great variety of ways.

The Daguerreotype Process. A silver plate of the required size, having been most carefully cleaned, is iodized, or bromo-iodized, by the exposure of its silvered surface to the vapour of iodine, or of iodine and bromine; it thus acquires a golden colour. Having been then placed in the camera and exposed to light for a length of time, varying with the state of the atmosphere, it is submitted to the action of the vapour of mercury, which brings out a picture that was before invisible. The silver salts which have not been decomposed by the action

* This is the second article of a series. The first, on The History of Photography, appeared in No. 27, April, 1864. The third and concluding paper will be given at an early date.

of light in the camera, are then removed by a strong solution of common salt, or a weak solution of hyposulphite of soda, which takes away the golden tint; and finally, the plate is washed with hot distilled water. If the exposure in the camera is allowed to exceed a certain limit, the mercurial vapour will bring out a negative, instead of a positive picture; since a certain amount of actinic action gives to the iodide, etc., of silver a power of condensing the mercury, while a greater amount takes that power away.

Process with Paper. A very simple process consists in soaking paper of a suitable texture in a solution of common salt, drying it in blotting-paper, and then brushing it with a solution of nitrate of silver. If the paper is required to be very sensitive, iodide of potassium is substituted for the common salt; and if extremely sensitive, bromide of potassium is used instead of either. The relative amounts of the salts employed is of great importance. After exposure in the camera, the picture is fixed with hyposulphite of soda.

The Calotype. The paper is washed with nitrate of silver, and then dipped in a solution of iodide of potassium: in this state it is unaffected by light, but it is rendered highly sensitive by washing with a solution of nitrate of silver, to which acetic acid and gallic acid have been added. When removed from the camera, the picture will gradually develop itself in the dark; but it is brought out at once, by gallo-nitrate of silver and heating at the fire. It is fixed with hyposulphite. Pictures obtained by this and similar processes are *negative;* positives are "printed" from them, by placing them in contact with sensitized papers, in a glass frame, and transmitting light through them, for a sufficient time.

Albumenized Paper. Paper which has been carefully coated with albumen on one side, and dried, is washed on the albumenized surface with nitrate of silver. After exposure in the camera, it is fixed in the usual way.

It has been found that the coating of albumen, containing the picture, may be removed from the paper, by steeping for a few moments in concentrated sulphuric acid, or in a concentrated solution of chloride of zinc, and washing carefully with water. The albumen then resembles an animal membrane, and may be placed on any other surface.

The natural tone of a picture on paper is very disagreeable: this is corrected by the *toning bath,* which consists almost essentially of chloride of gold, mixed with one or more other salts. Chloride of gold and bicarbonate of soda constitute the mixture very commonly employed. The toning bath should deepen the tint to a blue, a violet, or even a black, and it may be used either before or after fixing. The dearness of gold

has caused many attempts to substitute other substances for it: of those which have been tried, chloride of platina with acetate of soda gives the best results—it is nearly as effective as chloride of gold.

Albumenized Glass. A combination of several processes has been found most successful with albumen on glass. The albumenized plate is washed with a weak solution of nitrate of silver to which alcohol has been added, then with a mixture of protoiodide of iron, and afterwards with a strong solution containing nitrate of silver and acetic acid. After exposure, it is developed with protosulphate of iron, and fixed in the ordinary way. Albumenized glass, usually very slow, is by this method rendered extremely sensitive.

Waxed Paper. Suitable paper is carefully saturated with liquid wax, the excess of which is removed by blotting paper, and a moderately hot smoothing-iron. It is then immersed, for a considerable time, in a solution containing iodide and bromide of potassium, after which it is dried. When required to be used, it is sensitized with nitrate of silver and acetic acid: it is developed with a mixture containing gallic acid and nitrate of silver, and fixed with hyposulphite.

Moist Collodion Process. Common gun. cotton is almost entirely dissolved by a mixture consisting of about nine parts ether and one alcohol: the solution is *Collodion. Alcoléne* is a collodion containing no ether. It is obtained by dissolving a gun cotton which has been prepared with 100 parts by weight of concentrated sulphuric acid and 90 parts nitric acid, density 1·4 in alcohol, spec. grav. 0·803, and diluting the result, a thick gummy mass, with absolute alcohol, having an iodide in solution. If weaker acids are employed ether will be required for solution of the gun cotton. The best iodide for preparing a quick and stable collodion is that of cadmium; almost all others colour the collodion, and therefore diminish its sensibility.

A perfectly clean glass plate having been coated with the iodized collodion, which is allowed to solidify, but not to become dry, it is immersed in a solution of nitrate of silver, and then placed in the camera. The picture is developed with a mixture of pyrogallic and acetic acids, diluted with water, and is fixed in the usual way.

Protosulphate of iron may be used in the developing mixture, or—which is very much better—double sulphate of iron and ammonia, instead of pyrogallic acid; if formic acid is substituted for the acetic, the rapidity is augmented, and the picture is rendered more intense. Very good results are obtained if the picture is developed with protosulphate of iron, and intensified with pyrogallic acid and nitrate of silver, before the fixing or, if there is a tendency to fogging, after it.

Collodion negatives may be obtained with less than half the ordinary time of exposure by plunging the plate, after it has been sensitized with the nitrate of silver, into a concentrated solution of acetate of silver, and developing with pyrogallic acid.

If, after developing a collodion negative as much as possible by the ordinary method, a solution of sulphuret of potassium and a solution of protosulphate of iron are poured alternately upon it, water being used abundantly in washing it after each solution is employed, it will become so opaque as to be absolutely black and white.

Collodion proofs may be developed positive, by means of an alcoholized solution of sulphate of iron containing acetic acid and nitrate of potash, which makes the lights of a dead white; or with an alcoholized solution containing less iron and acetic acid, but nitrates both of silver and potash and nitric acid, which gives the lights a brilliant metallic appearance, The free acid in each mixture tends in a special manner to preserve the shadows. Without the alcohol the mixture would not run freely over the plate. Cyanide of potassium is used for fixing. The presence of a small quantity of copper in the sensitizing bath used with the paper for positives, causes it to afford vigorous and effective pictures from feeble negatives, but does not answer so well with good negatives. As, however, it renders the process tedious, it is objectionable to the professional photographer. If, after developing, the plate is drained, and coated with glycerine, it may be left for some days without being finished. The glycerine prevents the oxidation of the iron, and increases the adhesion of the collodion to the glass; it has the property of continuing moist, and is easily removed with water.

Dry Collodion Process. The glass plate having been coated with collodion, sensitized with nitrate of silver, and well washed, it is brushed over with a bromo-iodated solution of albumen, which preserves it from the decomposing action of light, so that it may be kept for two years or more. It must be sensitized anew at least one or two days before being used. Dry collodion requires four times as long an exposure in the camera as moist.

A preparation of malt, of malt and tannin, or of tannin and glycerine, has been used with great success instead of the albumen. Also ammonia has been employed with excellent effect in the development of dry collodion negatives; the time required, both for exposure and development, being greatly shortened. Ammonia, for some unknown reason, has no effect, occasionally: the development is effected in such cases with caustic potash.

Photography, with Textile, etc., Fabrics. Having been brushed over with a moderately thick mixture of Spanish white and alcohol, they are allowed to dry, after which they are carefully polished with cotton. Thus prepared, they may be treated like positive paper, and will give as good pictures.

Carbon Process. This has for its object a replacing of the salts of silver by carbon in an impalpable powder, which is imprisoned in a sensitive coating. It is founded on the fact that the persalts of iron communicate to organic matter, such as albumen, gelatine, or gum, an insolubility which ceases, under the influence of light, in presence of tartaric acid. The latter, in reducing the ferric compound, restores the natural solubility of the organic substance, and allows both it and the impalpable powder with which it has been combined to be washed away, in proportion to the action of the light, so as to reproduce on paper which has been coated with the mixture, all the varieties of light and shade. Gelatine has been found to answer best for the process. If only the under surface of the coating is rendered soluble, the parts containing the middle shades will be carried off in the washing, as well as those corresponding to the bright lights; this is prevented, either by causing the light to strike the outer surface first, or by modifying the details of the process. The means of attaining these objects have been well treated, in a paper read before the Photographic Society of Scotland, in December last, by Mr. Blair, of Perth. The fixation of the picture is effected by removing the ferruginous compound with acidulated water; and it is rendered still more permanent by means of alum or corrosive sublimate. The process has not yet produced results at all comparable to those obtained with the salts of silver.

The Chrysotype. Paper is washed with a solution of ammonia-citrate of iron, and dried. After exposure in the camera, the faint image then perceived is brought out strongly by washing with a neutral solution of gold, and is fixed by means of water acidulated with sulphuric acid, and subsequent treatment with bromide, or, which is better, iodide of potassium.

The Aurotype. Paper is washed with protocyanide of potassium and gold, then dried. It will now darken very rapidly when acted on by light, and the blackening continues in the dark. Several combinations of gold and cyanogen may be used.

The Platinotype. If a ferrocyanide of potassium and platina is formed, by mixing a boiling solution of chloride of platina, which is as neutral as possible, with a saturated solution of cyanide of potassium, and paper is washed with it, long continued exposure in a camera, during sunshine, will cause a faint impression to be produced; and washing with a solution of proto-nitrate of mercury changes this into a delicate

picture. But, whatever may be the details of the process employed, a platinotype slowly vanishes, even in the dark—though, in some cases, it gradually reappears.

The Catylissotype. Paper is brushed over with a mixture consisting of syrup of iodide of iron and tincture of iodine, and, when dried with blotting paper, is washed with nitrate of silver. After exposure, nothing is perceptible; but a picture gradually developes in the dark. The name of the process is due to the supposition that, when the silver salt has been slightly affected by the light, a catalytic action sets in, and extends itself to the salts of iron.

Enlarging of Images. The megascope, invented in 1780, is used to produce large from small proofs; thus, to obtain from a microscopic negative on glass, a portrait of the natural size. It never gives an agreeable picture, but skilful retouching may diminish its imperfections. The solar microscope answers well for the same purpose; the negative being placed in the focus of the objective, and the sensitized paper on a screen in a darkened room. The electric light may be used, but solar is preferable.

Heligraphy. This is understood to comprise the effects produced by light on non-metallic substances; but is applied especially to a development of the discoveries of Nicephorus Niepce, which has become very important, since it affords a means of obtaining impressions from metallic plates and lithographic stones. Niepce used asphaltum, but Daguerre remarked that all bituminous resins and the residues of essential oils are decomposed by sunshine. Vegetable juices, also, are sensibly affected by it. In the process employed by M.M. Lemaitre and Niepce de Saint Victor, a carefully cleaned plate of polished steel is coated with a solution of bitumen of Judea in essence of lavender, and dried by heat. A transparent positive is then placed over it, and after the bitumen, which has been rendered soluble by sufficient exposure to light, has been dissolved off by a mixture of rectified oil of naphtha and benzine, it is washed and dried. The plate is next acted on by nitric acid diluted with water and mixed with alcohol, and, having been again washed and dried, it is covered with finely powdered resin, and heated. This hardens the bitumen, and in the shadows forms granulations which give good impressions with ink.

If a picture is obtained with bitumen, by the method of Niepce, and the plate is then placed in an electrotype apparatus, copper will be deposited upon it, on connecting it with the negative pole; but it will be corroded in the lights, on connecting it with the positive. A plate may, therefore, be obtained which will give impressions like an engraved copper-plate, or like an engraving on wood.

Photolithography. The stone is covered with a varnish consisting of bichromate of ammonia, water, and albumen, and when dry is exposed to light, under the engraving, etc., which is to be copied. Nothing is visible until the surface of the stone is washed with Marseilles soap, which removes the soluble portions—those where no insoluble oxide of chrome has been formed, and which, being allowed to act for a sufficient time, slightly hollows the stone wherever its surface has been laid bare. If it is then wetted and inked, as for lithography, the ink enters the hollows, but it is repelled from the parts in relief, which are to form the lights. The engraving, etc., is not reproduced in reverse, nor is it injured by the process of preparation.

Barreswil's method consists in covering the stone with a solution of bitumen of Judea in ether, which forms, not a varnish, but a granulation. A negative is laid on this; and the portions of the bitumen rendered soluble by exposure are washed off in the usual way. Impressions may then be taken from the stone; and, for some time, each is better than the preceding one.

Zinco-photography. Paper is prepared with bichromate o potash and gelatine, and, after having been exposed under a negative, is covered uniformly all over with ordinary lithographic ink; it is then washed with gum water, which removes the unaltered gelatine, and leaves a well-inked positive picture. This is transferred to a properly grained zinc plate, by pressure; after which the process is that ordinarily used with zinc.

Photographic Engraving. Dilute nitric acid dissolves the silver from a Daguerreotype, without acting on the portions covered with mercury. In this way may be obtained a plate which will afford a few tolerable impressions. A great improvement is effected by rubbing grease into the cavities formed by the acid, gilding the prominent parts by the electrotype process, and then deepening the hollows with acid. The plate must then be finished with the burine, which of course injures its truth as a photographic product.

Photography in Relief. A sheet of gutta-percha is coated with a mixture of gum arabic and bichromate of potash, and when dry is exposed in the camera. The parts of the gum which have thus been rendered soluble are then washed away with water; after which the sheet is dried. It is next held horizontally, the gummed side being under, and, the corners being pinched up so as to form a kind of rectangular trough, hot water is poured upon it. This causes the gutta-percha to become prominent wherever the gum has been removed; and thus the lights appear in a relief, which is unfortunately too great.

General Coloration of Photographs. Besides the care usually

bestowed on toning, the uniform tinting of photographs has received considerable attention, as a means of improving their appearance. This is brought about in various ways. If, before exposure, a paper positive is placed for a short time in a solution of uranium, then, on being taken out of the camera, is washed for a few seconds in water at a temperature of from 122° to 140° Fahr., and, immediately afterwards, is plunged into a solution of red prussiate of potash, it will soon acquire a fine red colour. Being now dipped in a solution of nitrate of cobalt, and dried at the fire, it will become green; and this colour is fixed by immersing in a solution containing sulphate of iron and sulphuric acid, washing with water, and drying at the fire. If a solution of prussiate of potash is used instead of that of uranium, and a solution of bichloride of mercury, saturated in the cold, after the paper has been taken from the camera, followed by a solution of oxalic acid heated to from about 122° to 140° Fahr., the colour will be a beautiful blue.

Heliochromy. Among the various processes used by Niepce de Saint Victor for the reproduction of colours, the following were found to be the most effective:— A plate, like that used for the Daguerreotype, is immersed for ten minutes in a solution of chloride of copper, or of iron, saturated to a degree suited to the reproduction of the mean colours of the spectrum, and then gently heated with a spirit-lamp; if light which has passed through a transparent coloured picture is now thrown upon it, the various tints will be produced, but will vanish immediately. If, however, the bath employed consists of half proto or sesquichloride of iron and half sulphate of copper, the colours of objects are reproduced with great vividness, with the exception of yellow; and even this is obtained by using a bath of hypochlorite of soda, containing some alcohol and raised to a temperature between 158° and 176° Fahr., stirring the plate about in the mixture, until it is nearly black, then washing with water, and drying with the flame of a spirit-lamp. Before exposure, and while still lukewarm, the plate is coated with a varnish which consists of dextrine and chloride of lead, and dried by heat. This varnish causes the colours to appear with great brilliancy, and brightens the white ground, on account of the chloride of silver being bleached by the chloride of lead. When a bath consisting of dentochloride of iron and sulphate of copper has been used, *fused* chloride of lead prepared directly from the metal must be employed; but, when a bath consisting of hypochlorite of soda, *unfused* chloride of lead, that it may neutralize the action of the alkaline solution, and tincture of benjamin of Siam is to be added to the varnish. After the picture has been obtained, the plate is to be heated, gradually, to the highest point short of carbonizing the organic

matter. This, if the whole thickness of the sensitive coating has been acted on by the light, intensifies the colours, otherwise it changes the blues to violet, and the black to red. It renders the tint so permanent that, when the iron and copper bath has been used, they are not destroyed by less than ten or twelve hours' exposure to diffused light; and when the soda bath, not by less than three or four days' exposure to the bright light of summer. The colours, in these processes, make their appearance one after another. Those of natural objects, on account of the white light always mixed with coloured rays, are more or less vitiated; and when the hues of the spectrum are reproduced, a disagreeable violet shade is found to pervade them all. The binary colours, or those formed by a union of two, are decomposed by heliochromy; hence the green of the emerald will be reproduced by it; but the green formed by a mixture of chrome yellow and Prussian blue, will afford only blue. It has been asserted that the colours may be completely fixed by alloxan; but this requires confirmation.

Encaustic Photography. A thin glass plate is coated, in the dark, with a mixture consisting of bichromate of potash, honey, white of egg, and water, and dried in a gas stove. It is next placed under a positive, in a copying frame, which produces upon it a weak negative. Pulverized enamel is then rubbed on with a soft brush, until a good positive is produced, which is fixed with alcohol, to which a little acetic or nitric acid has been added; when the alcohol has evaporated from its surface, it is put horizontally into a dish containing water, and left there until the chromate is dissolved out. The picture in enamel remains, and, having been properly dried, is put into the furnace.

A CHEAP OBSERVATORY.

BY FREDERICK BIRD.

THE writer of this article was for several years of the number of those observers who ply their starry occupation for the most part in the open air, and can well sympathize with his brethren under the many difficulties with which their pursuit of knowledge has to be carried on. He commenced his career by casting a metallic speculum, and fabricating a telescope with his own hands. His out-door station was at a wooden turn-table, having around it a circular bricked pavement, and many were the delightful hours there spent in hunting up nebulæ and the double stars.

Out-door observation has, no doubt, its advantages. Telescopes are generally understood to work best when the object-glass or speculum has attained the temperature of the surrounding air. And certainly those who wish to familiarize themselves with the constellations, and the names and peculiarities of their leaders, as the more prominent stars are called, will get on much better in the open air, with the whole heavens before them, than when looking through the narrow opening of an observatory.

But when the higher purpose of close telescopic scrutiny is the intention, then the shelter and many conveniencies of the observatory are indispensable.

So immensely remote are even the nearest of the heavenly bodies that for the most part we know little or nothing of the nature of their surfaces. The pencillings on their discs of lines, streaks, or spots, arising from clouds, oceans, mountain chains, or other unknown peculiarities of their structure, are by the mere effect of distance reduced to the utmost delicacy, and require not only the best optical means to reveal them, but also that the observer himself should be placed in an easy posture, and be perfectly free from bodily inconvenience.

The most interesting part of an amateur astronomer's work consists in observing such details, or in picking up minute objects amongst the fixed stars, measuring the interval separating double stars, determining as nearly as may be angles of position, and watching for variation—*one of the most useful matters to which an amateur can devote his attention*—occasional sketches of lunar craters under different degrees of illumination, solar spots, as the great orb rotates and brings them into view; noting the occultations of stars by the moon, with a view to decide the question, yet unsettled, of a lunar atmosphere; and many other niceties of observation which not only invest his labours with interest, but impart to them a real value. To do any of these things, however, effectively in the open air, with one's telescope agitated by the passing wind, and a body shivering with the cold, is clearly next to impossible.

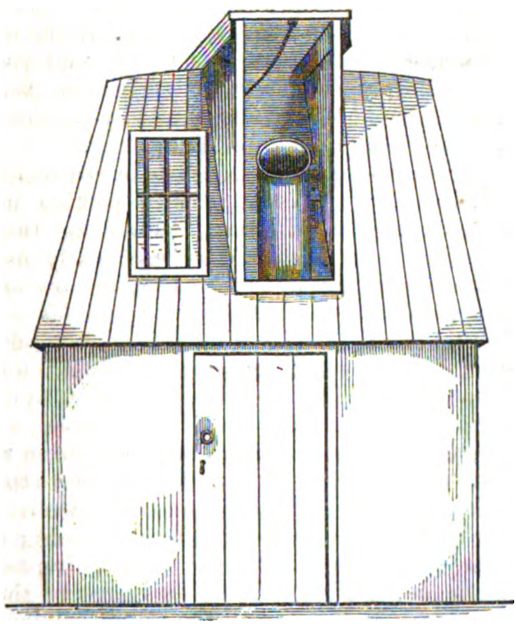
This remark then leads to the main object of the present article, namely, to describe a "cheap observatory," which the writer has recently erected for himself, and to show that at a very moderate outlay an amateur, who has the convenience on his premises for the erection of such a building, need not to remain destitute of it.

He was led to the erection of an observatory chiefly to afford greater protection to a fine silvered glass speculum, of twelve inches aperture, some account of which appeared in a former number of the INTELLECTUAL OBSERVER. Since then he has completed a much finer one, of a similar aperture, having a focal

length of nine feet, fixed in an iron tube, and mounted on a fine mahogany stand by the late Charles Tulley.

The observatory is erected on the summit of a sand rock, about sixty feet above the surrounding surface, and within eighty yards of the Great Western Railway. The weight of the rock is fortunately sufficient to absorb all tremors from the passing trains, from which when below there was a constant annoyance, tremors being often perceptible after the train had passed out of hearing.

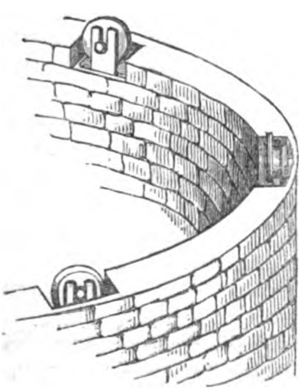
The aspect of the observatory is nearly all that could be desired, being completely open except in the extreme north, and even there a view of all objects 8 deg. below the pole can be obtained. The exterior of the building with the front shutter taken down is represented by the following sketch.



It consists in the first place of a circular bricked building carried up exactly five feet high, with a low entrance door-way sufficiently wide to admit the telescope stand. And as economy in the materials and every part of the erection required to be strictly observed, the bricks of which the building is composed were old ones that had done duty for several years before, on the same spot, in the shape of a summer arbour. They were pulled down, cleaned, and reset, and being for the most part

broken and fragmentary, were all the more suitable for turning the sharp curve. The walls are nine inches thick throughout, and the interior diameter of the enclosed space nine feet. Two courses from the top, and at equal intervals, are inserted six slabs of stone, to which are securely bolted the cast-iron chairs carrying the flanged wheels, on which the roof was intended to revolve. The wheel and its axle, and the chair, were cast in separate pieces, and required, therefore, only two very simple patterns. The wheels required turning in a lathe to render them true, but the chairs were trimmed up and finished with a file, and the whole when completed cost exactly 22*s*. In setting the wheels great care was bestowed to range them accurately in a circle, and to ensure this each one as set was tested by a wooden radius working on a firm support at the centre. They were also accurately levelled, the one from the other, and when finished, the upper bearing edge stood half an inch above the level of the final ring of brickwork.

The diameter of that part of the wheel which carries the weight is four inches. The flange extends beyond this three-quarters of an inch more, and the surface of the bearing part is one inch wide, which allows for slight irregularity in the iron circle. It might also be mentioned that in order to do away with friction, the flange is not perpendicular to the bearing surface, but reclines away from it, hence the edge of the iron ring comes in contact with the flange only at its base. The wheels may appear rather small, but they are found to answer most perfectly, and the roof moves with freedom. Out of the six wheels it rarely happens that more than three take a bearing at one time, but when one leaves off another begins.



A sketch of their appearance when *in situ* before the roof was put on is here given. We next come to the wooden part of the building, namely the roof. Here again economy interposed and forbad all the woodwork being planed, so it was used up simply as it came from the saw.

The framework of the roof is made up of two circles, four vertical standards, and two cross beams. The circles are both of elm, and were cut in segments from boards one-and-a-half inches thick, they were placed end to end on a level floor and united by other segments only an inch thick, these were laid across the joints, and all firmly united by screws.

The larger circle is ten feet and the smaller eight feet in diameter. The latter was mounted over the former on the four uprights, and the cross beams laid in their places and well secured.

The sides were then covered in with light deal boards, the edges of which being ploughed and tongued the joints were rendered quite close and perfect, at the same time they were securely nailed to the elm circles above and below.

For the greater comfort of being well inside the building when observing, instead of the front shutter being formed on the sloping surface, it was thought better to carry the cross beams, on one side, some distance beyond the edge of the roof, to be met by uprights standing vertically on the lower elm circle, the intervening surface being boarded up and forming a kind of porch. A window also was inserted on the right-hand side of the porch, for the convenience of light in the day time. The top surface of the roof and sliding shutter were boarded over, and then covered with zinc, which was also carried a few inches down the sides, rendering all perfectly watertight. The sliding shutter referred to moves on rollers between two strips of timber laid across the top of the building under the zinc, and is opened or closed by means of a continuous cord, the ends of which are attached to the opposite ends of the shutter and pass over appropriate pulleys, so that it can be completely controlled without the necessity of going up to it. The upright shutter is removed entirely when a front view is required.

It now merely remains to state that a facility for motion was given to the roof by attaching an iron ring to the lower elm circle. It was formed out of pieces of flat bar iron two inches wide and about four feet long each, holes were drilled through and counter sunk, and the bearing edge made straight, the bars were then heated and bent to the required curve, they were put on end to end, but not quite in contact, in order to leave room for expansion, and very firmly screwed to the circle. The roof was then lowered down, and when the iron edging rested on the wheels, the whole fabric was put in motion with a very slight effort. The movement was rendered still easier by several convenient pushing handles afterwards inserted, and a good supply of grease to ease the friction. A few minor details remained to complete the structure, such as painting inside and out, a bricked floor laid upon a thick bed of ashes, a convenient shelf a foot wide carried completely round the building above the large elm circle, from which depended a valance of oil baize intended to hide the wheels and also to check the draft. The building has now been in use for several months, and nobly stood the ordeal

of the great wind storm which swept over the country not long since, the only mishap being a flight of the top shutter which was left unfastened.

The comfort and convenience of the building has been found very great, and the performance of the specula immeasurably superior to what it ever was when they were used in the open air. They are left permanently in the tube shut up with tin covers, fitting closely to the cells in which they are mounted, and further protected from damp by a bag of sawdust which has been steeped in a saturated solution of the chloride of calcium and afterwards baked thoroughly dry. Thus protected their surfaces retain all their original splendour, and are reflective in the highest possible degree. On reckoning up the entire cost of materials and workmanship, it was found not to exceed the very moderate sum of £14.

Should any observer of the heavens, reading this account of a cheap observatory, be resolved to get under the shelter of a revolving roof, it would afford the writer pleasure to aid him by any explanations and suggestions not already mentioned in the foregoing article.

General Cemetery, Birmingham.

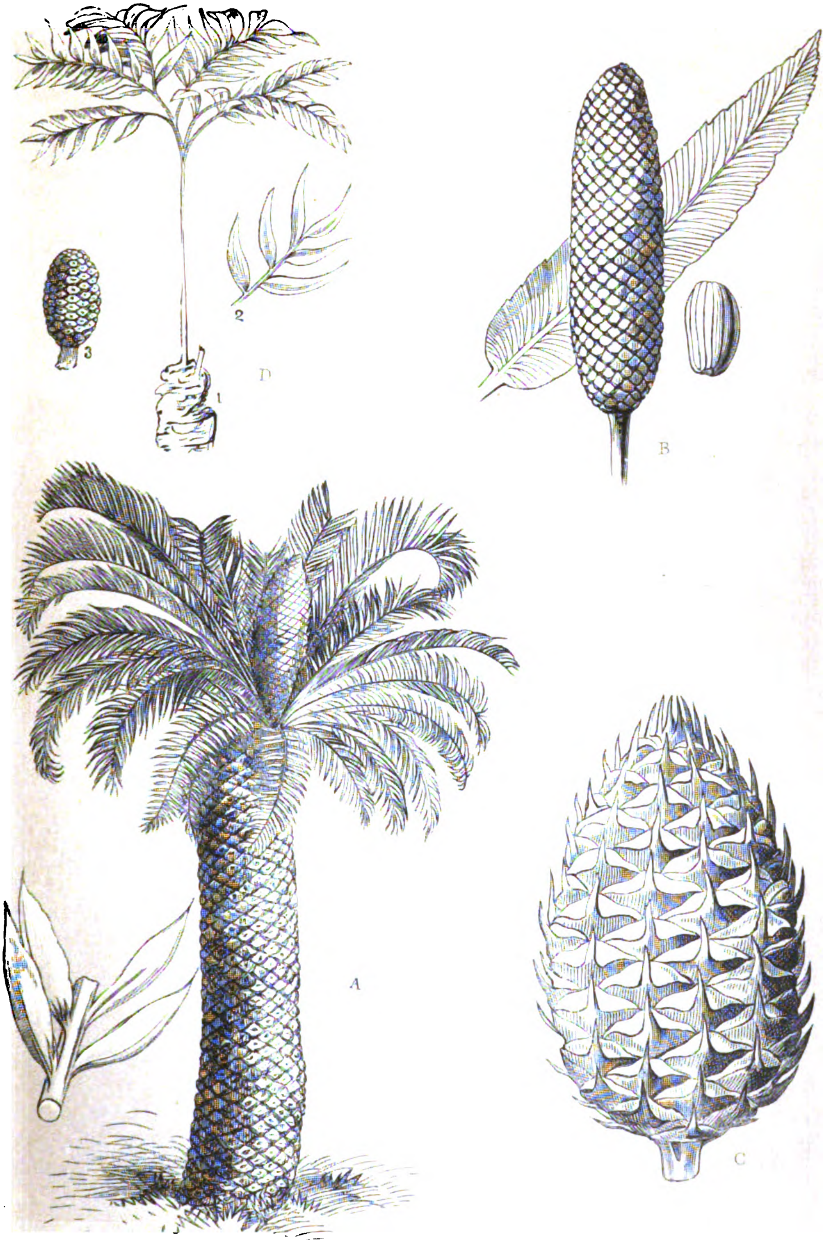
CYCADS.

BY JOHN R. JACKSON,

Curator of the Kew Museum.

(*With a Tinted Plate.*)

There is something strange and peculiar about the cycads—something wierd and pre-Adamitish about their very appearance—which fixes our attention, even at the first glance, and the more closely we examine into the history of these plants the more interesting does it become. In the whole range of the vegetable productions of our globe it would be difficult to select a group of plants to which more of interest is attached. There are not very many of them, perhaps not more than 70 or 80 species, at present existing. Their geographical range is somewhat extended, for we find them in Africa, in America, the West Indian Islands, and in Australia; they are the scattered remnants, the living representatives of a bygone flora. They form a little family circle, completely isolated from the remainder of the vegetable world. They have no close ties of relationship connecting them with any other group of plants, although possessing external resemblances to several. So peculiar and



CYCADS.

Fig. A. Encephalartus Caffer, Lehm.

Fig. B. Male cone of Stangeria paradoxa, Moore. With seed and leaflet quarter natural size, showing venation.

Fig. C. Female cone of Macrozamia spiralis.

Fig. D. Bowenia spectabilis Hook. 1. General appearance of plant. 2. Form of leaves. 3. Male cone half natural size.

well marked are the characters by which they are known, that having once become acquainted with them, the family likeness is at once recognized.

It is very strange that so remarkable a family, and one whose history is fraught with so much of interest, we might almost say of romance, has never yet found a biographer; no one has taken the subject in hand, and any one wishing for information concerning the cycads must seek for it in brief notes and passing allusions in a hundred different works. No man has undertaken the duty of introducing this family to the British public. That pleasant task has fallen into our hands, and we believe that the readers of the INTELLECTUAL OBSERVER will find something to interest them in the subject of our paper, if not in the manner in which it is treated.

In their cylindrical, undivided stems, surmounted by a crown of foliage, the cycads resemble palms. A good idea of the general habit of the family is shown in Fig. 1, which is a sketch of *Encephalartos Caffer*, Lehm., from a fine specimen growing in the Royal Botanical Gardens, Kew. It will be seen that the stem is undivided, growing only at the apex, and that the lower parts are marked with the scars of the old leaves. In exceptional cases the stems are divided dichotomously. In this again cycads resemble palms, for there are one or two examples of forking stems even among the palms, as Hyphœne for example. In the germination of their seeds, too, there is a similarity between them; but then, again, if we look at the venation of the leaflets of their pinnate fronds we should be inclined to think there must be some relationship with ferns. The arrangement of the veins is precisely that found in the free-veined ferns, as shown in Fig. 2; indeed, when the fronds of this plant were first sent to this country, without either stem or fruit, they were believed to belong to that family, and the plant was, by Kunzé, a first-rate authority upon ferns, published as a species of Lomaria.

The most characteristic feature of the ferns, and one which most persons would look upon as being a distinctive mark of the family, is the gyrate vernation of their fronds; that is, their being coiled up, like the head of a crozier, in their young state. But this we find is also a character observed in the majority of cycads. While their habit of growth resembles the palm, their venation and vernation is, to all appearance, fern-like; but their floral organs and their fruits, which are, of course, the most important parts, give us the resemblance of a third great natural order—*Coniferæ*, the fir-tree tribe. The flowers are unisexual and without floral envelopes (*achlamydeous*). In the male cones the one-celled anthers are scattered in sessile clusters over the lower surface of the scales. The anthers split

up longitudinally. The fruit is produced in cones, closely resembling in many cases those of various kinds of conifers (see Figs. 2 and 3). The size of their cones varies much with the different species, in some, as those of *Encephalartos,* they are of immense size, frequently measuring two to three feet in length. The hard-cased nut-like seeds are either arranged along the sides of altered leaves or scales as in *Cycas,* or at the base of the peltate scales, as in *Encephalartos.* The seeds of *Cycas* are as large as a walnut, while those of *Stangeria paradoxa* much resemble hazel-nuts.

With such peculiar features as those above described, it is not to be wondered at that the early botanists were much puzzled as to the affinities of cycads. Thus we find that Linnæus himself was at first inclined to class them with palms; but he subsequently changed his opinion, and, with Adanson and some other authorities, gave them a place among ferns. After considerable discussion upon this difficult subject, M. Richard came to the conclusion that they should constitute an order by themselves, under the title of *Cycadeæ;* but he still retained them as near allies of the two former orders, giving them, in fact, a place intermediate between palms and ferns. Subsequent researches have proved that though they resemble these natural orders, yet they have no true affinity with them. The cycads are now placed in what is no doubt their true position, that is among Gymnogens, a class intermediate between Endogens and Exogens, and associated with conifers, taxads, (yews), and joint firs, from each of which orders, however, they are totally distinct.

The cycads may claim a high antiquity, for they certainly existed in considerable numbers in this country during the Oolitic period, as their remains well preserved in the strata at Portland abundantly testify, and they may have existed even earlier. It is not at all improbable that some of the fronds found in the Carboniferous strata, and usually looked upon as ferns, are in fact cycads. The texture of the fronds was evidently thick and leathery; a characteristic of the family we are speaking of, but much more rare among ferns. The essential character of the flora of the Lias period is the predominance of Cycadeæ, says Dr. Balfour; we find in strata of that age many species of Cycadites, Otozamites, Zamites, Ctenis, Pterophyllum, Nelsonia, and other allied genera. There are few flowering plants which can be traced further back. Cycads formed, doubtless, part of the food of that mighty reptile, the Iguanodon, which trod this earth when the Wealden beds were deposited. The family must have made an important part of the flora of this country at that remote period; but with the changes of climate and circumstances, brought about during the great

length of time which has since elapsed, the cycads have been driven southward, until not a single species is now found in Europe. They are not alone in this respect, for palms and gigantic tree ferns flourished here too. Only one or two species of palm now exist north of the Mediterranean, and no example of a tree fern. The genus *Banksia*, which we now look upon as being more characteristic than perhaps any other of the Australian flora, was, there is reason to think, at one time, a native of this country. We cannot be surprised therefore to find that the cycads have all emigrated: let us see where we find their descendants settled in our own day.

The geographical distribution of this family is not confined within such narrow bounds as was supposed a few years ago, many new species, and new localities for old ones, have been recently discovered. They are perhaps more plentiful in South Africa than in any other part of the world. Mr. Bunbury, writing in the *London Journal of Botany*, says that Zamias are among the forms of vegetation that characterize the eastern parts of the colony of the Cape of Good Hope, especially the great tract of thicket extending along the Caffir frontier. It was formerly supposed that they were not to be found in the regions of tropical Africa, but the researches of Barter upon the Niger, and Gustav Mann upon the west coast, prove this to have been a fallacy; some fine cones collected by these two botanists now enrich our national collection at Kew, as well as some specimens sent by Dr. Kirk of the Livingstone Expedition. Among the species most plentiful in South Africa are *Encephalartos Caffer*, *E. horridus*, and *E. pungens*. Cycads are also found in Mexico, the East and West Indies, in Madagascar, the warmer parts of Asia, and some of the South Sea Islands. The recent researches of Dr. F. Mueller of Melbourne, and Mr. W. Hill of Brisbane, have added much to our knowledge of the Australian forms of this family. One most interesting species, for the knowledge of which we are indebted to the latter botanist, we must mention. It is *Bowenia spectabilis* (Fig. 4), of which an admirable figure by Mr. W. Fitch was published in the *Botanical Magazine* (T. 5398). We borrow the following remarks from Sir William J. Hooker's description of the plant, published in that valuable work:—"The discoverer of this singular plant was the late Allan Cunningham, from whom we received, upwards of forty years ago, a portion of a frond, collected at the Endeavour River (lat. 15 deg. S.) in 1819, and referred by him provisionally to *Aroideæ* (*Dracontium polyphyllum* M.S.) Nothing, however, was known further of it till Mr. Walter Hill, the zealous and able head of the Brisbane Botanic Gardens, re-discovered it in Rockingham Bay, and sent a young living plant, with full-

grown dried leaves, and a male cone, to the Royal Gardens, Kew, in 1863. From these materials the plate and description have been made, and, in accordance with Mr. Hill's desire, as well as our own, we have attached the name of the present enlightened Governor of Queensland (Sir George F. Bowen, G.C.M.G., Captain and Governor-in-Chief) to the genus, in recognition no less of that officer's position as Governor of the district of Australia in which the plant was found, than of his liberal encouragement to botany, and of Mr. Hill's exertions in particular. As a genus, the most prominent character of Bowenia is the compound leaf, its general characters (all but shape), texture, and venation; the leaflets do not differ from those of Macrozamia, and are so very similar to those of some West Indian Zamias that it is difficult to distinguish them generically, except that in Bowenia the leaflet is decurrent by the petiole, and not articulate with the rachis. The habits of growth, caudex, etc., entirely accord with that of the South American Zamias, as does the male amentum; the female amentum and fruit are both at present unknown, but we trust ere long they will be detected and published."

Bowenia is a unique example of a cycad, possessed of leaves which are more than once divided—the normal character is the pinnately divided frond, as shown in Fig 2. The plant whose leaf we have selected as an example is one possessed of peculiar interest, as we have before mentioned, on account of its great resemblance to the fern family in its venation. Its stem is short and globular, and, unlike most of the family, it is not marked with the scars of fallen leaves. When first introduced into this country, now about twelve or fourteen years ago, the plants from their novelty realized large sums of money—several stems selling for £5 or more a-piece.

One of the finest collections of living specimens of this family in Europe, if not, indeed, the richest, is that at our National Botanic Garden at Kew. A very large number of species may there be seen growing in all their native luxuriance in the magnificent Palm House. Fig. 1 will give an idea of one of these, which must be of enormous age; it is probably one of the oldest plants in the garden, and must have passed through many vicissitudes in its native land ere it was transported to our country. The lower parts of the stem are partially charred upon the outside, which looks as though it had suffered in one or more of the bush fires so common in that country. But it has survived all its trials, and is now in robust health, and will probably be so, we might almost say, for centuries to come. The garden of James Yates, Esq., of Lauderdale House, Highgate, also contains a magnificent collection of cycads, including many rare species. In the Botanic Garden

of Hamburgh, and one or two other continental gardens, there are likewise good collections.

There is a great and general partiality on the Continent for the commoner kinds of cycads which are grown for decorative purposes. In many of the small nursery gardens round Dresden, *Cycas revoluta* was, a few years ago, extensively cultivated; whole hothouses were devoted to numerous specimens of this one plant, and it would appear to be a profitable business the growing of these plants, for it is a very general practice for the mourners at a funeral to carry fronds of this plant in their hands when following a departed friend to the grave. The custom originated, it is said, among the Jews, but is not now confined to them. They are well adapted to the purpose, being somewhat rigid and yet gracefully curved, and as the pinnæ are numerous, narrow, and thickly crowded together, they have somewhat the appearance of green feathers on a large scale. The resemblance of the fronds of cycads to those of palms has led to their being substituted for them in many Roman Catholic countries where palm branches cannot be obtained, and they are often carried in processions on Palm Sunday. In New South Wales the fronds of Macrozamia are generally used for this purpose.

Cycads have their economic uses, too, and are therefore looked upon as valuable plants in some of their native countries. Thus we find that from the nuts of *Cycas circinalis*, L., which is very abundant in many of the East Indian forests, especially in Malabar and Cochin, a kind of sago is prepared. For this purpose the nuts or seeds are exposed to the heat of the sun for a few weeks to dry, the kernels are then taken out and pounded in a mortar. This flour is extensively used by the forest tribes and poorer classes of the natives in various parts of India and Ceylon. This plant grows also in the Fiji Islands, but not very plentifully; a kind of sago is there prepared from the pith of the stem, but on account of the comparative scarceness of the plant it is not an article of general use, and is used only by the chiefs and their guests. From this species a clear transparent gum-resin exudes, which hardens by exposure to the sun and much resembles gum tragacanth in appearance. This gum in India has the repute of being a good antidote for snake bites, and is also used for ulcers of all descriptions.

The genus Macrozamia has a wide distribution in Australia. The nuts of *Macrozamia spiralis* form an article of food in times of scarcity; they have, however, little to recommend them, and unless properly prepared are apt to produce unpleasant effects upon the system. This can be obviated by first steeping the nuts in water and then roasting them. A quantity of gum, resembling tragacanth both in substance and appearance, is

exuded by the cylindrical half-buried stem of this plant. Gum is also exuded by the fruit, but it is darker and more transparent than that obtained from the stem.

In the Bahamas, the natives prepare a kind of starch from the trunk of *Zamia tenuis*, Willd., which they use as arrowroot, and for which, being very pure, it is a good substitute. In many of the West Indian Islands another species of the same genus, *Z. furfuracea*, Ait., furnishes a similar article of food. *Dion edule*, L., is a native of Mexico, and an abundant supply of starch is there obtained from its seeds, and forms by no means an unimportant article of food. The nuts of this plant are much larger than those either of Cycas or Zamia, and approach nearer to those of the Australian genus, Macrozamia, the ordinary size of them being about that of a common chesnut, though occasionally seen much larger.

It will be seen that starch, or sago, is produced by most of the plants belonging to this order, and may be prepared either from the trunk or the seeds. This, naturally enough, led to the belief, some years ago, when the true source whence our commercial sago was obtained was yet unknown, that it was furnished by these plants. They were then looked upon as palms, and the East Indian species acknowledged without doubt as furnishing the source whence our supplies were obtained; more recent researches, however, prove that the sago so largely imported into this country is obtained from a true palm.

We have thus attempted to describe the peculiarities, value, and uses of one of the most singular natural orders in the whole vegetable kingdom. Their interest is not confined to one point, but is manifold, whether as to their singular habits, their geological history, or their present economic uses. The cycads therefore deserve a greater claim upon our attention than has been hitherto given to them.

DISCOVERY OF POISON ORGANS IN FISHES.

COMMUNICATED BY HENRY WOODWARD, F.Z.S.

ALL comparative anatomists, from Cuvier down to the present day, have decided to treat the accounts given by Pliny, Ælian, and Oppian, and other old writers, of the poisonous nature of wounds inflicted by fish-spines as incredible, and only deserving a place among "Old wives' fables." Cuvier observes, "having no canal, nor communicating with any gland, they are unable to shed any venom, properly so called, into the wound."

Notwithstanding the verdict of science against the common belief of fishermen, not only on our own coasts, but on the shores of France and Spain, and among the natives of India also, the conviction has always prevailed, that certain fishes (belonging to the family of *Acanthopterygii* or perches), armed with strong spines upon the gill covers and the dorsal fin, inflicted poisonous wounds with these defences.

That this is really so would seem to have been proved by numerous cases recorded upon good medical authority, of severe inflammation and permanently stiffened joints, resulting from punctures inflicted by the spines of the "common weever," or "sting-fish" (*Trachinus vipera*), of our shores.

The virulence of such injuries, has, however, always been referred, in books upon natural history, to the rugged and lacerated condition of the wound, or to the serrated form of the spine which caused it. This may be true in the case of wounds caused by the cat-fish and other Siluroid fishes armed with serrated spines; but certainly does not account for the virulence of wounds produced by smooth-spined fishes like the perch family.

Professor Allman made a most interesting communication upon this very subject, so long ago as November, 1840, to the *Annals and Magazine of Natural History* (vol. vi., p. 161). He there says, "On the 9th August, 1839, I was wounded near the top of the thumb by a *Trachinus vipera,* which had just been taken in a seine with herrings, sand-eels, etc. The wound was inflicted by the spine attached to the gill-cover, during my attempt to seize the fish. A peculiar stinging pain occurred a few seconds after the wound, and this gradually increased during a period of fifteen minutes. The pain had now become most intolerable, extending along the back of the thumb towards the wrist; it was of a burning character, resembling the pain produced by the sting of a wasp, but much more intense.

The thumb now began to swell, and exhibited an inflammatory blush, extending upwards to the wrist.

The pain was now distinctly throbbing and very excruciating. In this state it continued for about an hour, when the pain began somewhat to subside, the swelling and redness still continuing. In about an hour and a half the pain was nearly gone. Next morning the swelling of the thumb had but slightly diminished, and was in some degree diffused over the back of the hand, the thumb continued red and hot, and painful on pressure over the metacarpal bone. In a few days the swelling had completely subsided; but the pain on pressure continued for more than a week."

The spines of the opercula in this fish, of which we have two species (the *Trachinus vipera* and the *Trachinus draco*), are deeply grooved along their edges, each groove terminating at the base of the spine in a conical cavity. The integument is continued over the spine to within a very short distance of the point, forming a complete sheath for nearly its entire length, and converting the grooves at each side into perfect tubes, extending from the base to the point of the spine. The result of this arrangement is a structure beautifully adapted for the conveyance of a fluid from the base to the apex of the spine.

The spines of the dorsal fin in the Weevers are also grooved, but the grooves become superficial, and disappear towards the base, and do not terminate in cavities similar to those at the bases of the spines of the opercula. Professer Allman did not succeed in detecting any specific gland connected with this apparatus, but at the bottom of each of the conical cavities of the opercula he noticed a small pulpy mass, which he considered might possibly be a glandular structure; but he adds, "In ascribing to it the property of secreting the virus, I do nothing more than hazard a conjecture."

The next recorded observations upon this subject are by Isaac Byerley, Esq., in the *Proceedings* of the Liverpool Literary and Philosophical Society, vol. i. p. 156, May, 1849.

Mr. Byerley records carefully the effects produced by wounds from these fishes, and gives also sections of the spines, to show the side grooves which Dr. Allman had already described. He says it has been suggested that the fish is capable of secreting mucus from its skin of great acridity, which, following the spine into the wound, might produce the effects mentioned. A large quantity of mucus is secreted by means of glands under the skin in all fishes, but it would, Mr. Byerley considers, be very remarkable that the *Trachinus* alone should secrete it of so irritating a quality. The upper part of the membrane covering the spines, especially the opercular ones,

forms such loose envelopes to them, that it is quite possible a portion of such secretion might intervene between the spine and its sheath, and, in that case, the spine would always have a charge of virus ready for use.

I always (he adds) favoured the idea that acrid mucus, either normally so formed, or the result of excitement, was the cause of the phenomena we have been considering until recently, but having observed a new structure occupying the grooves in the spines, which appears to be an organ destined to secrete a specific poison, I have willingly given up the doubtful for what appears to be a certain cause.

And it was just this one mistake which *prevented* Mr. Byerley and his friend Dr. Inman from arriving at probably the true solution of this interesting anatomical point.

Dr. Inman (Mr. Byerly tells us) was fortunate enough, not having an immediate opportunity of examining the fishes in their fresh state, to immerse them in spirit and water, in consequence of which the gland became more opaque and denser.

I (he adds) always had fresh fishes at hand, and in preparing the parts for examination without having used spirit, must have torn the gland from its usual resting-place. *In fact* what Mr. Byerley saw *only in spirit-specimens,* was, in reality, no organ at all, but the *coagulated* mucus fluid occupying the opercular grooves and the space within the integument of the spine, which only became visible from the effect of the spirit upon the secretion. The structure which he figures and describes as glandular, is merely the thickened appearance of this fluid under the microscope.

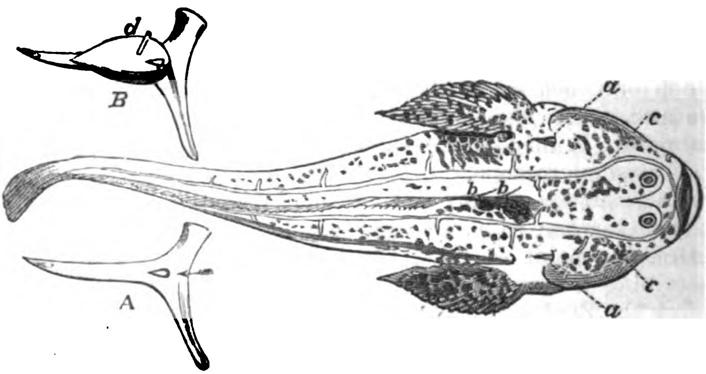
It remained for my distinguished friend and colleague Dr. Albert Günther, to give a complete demonstration of this most interesting point of Ichthyological anatomy. He did so in describing a new species of Batrachoid fish, from Panama, before the Zoological Society, on 22nd March last.

Dr. Günther remarked that many fishes were dreaded on account of their spine defences, such as the Sting-rays and Siluroid fishes, and some scaly fishes, as the Weevers. Exaggerated accounts, no doubt, were often circulated of the venomous nature of these fishes; still, in some cases, it seems certain the wounds must have been poisoned. No trace, however, of an organ secreting a poisonous substance could be found, and all handbooks of comparative anatomy denied the presence of such a gland in any fish.

The axil of the pectoral fin of many Siluroid fishes, Dr. Günther observed, contained a cavity with a mucous fluid, which might be introduced into a wound by means of the pectoral spine like the poisoned arrow of the Bushman. He had no doubt of the poisonous nature of the contents of

this axillary sac after discovering in another genus of fishes a poison-organ which structurally is identical with and as complete as that of the venomous snakes. This fish belongs to the family *Batrachidæ*, and a single species of the genus has already been described in the Museum catalogue of fishes, part iii. page 174, under the name *Thalassophryne maculata*. Being a very small species, Dr. Günther did not discover the apertures in the spines, although really existing. A second species having been recently brought over with a collection of fishes from Guatemala by Messrs. Salvin and Godman, which has been named *Thalassophryne reticulata*, being ten and a-half inches long, the structure of these spines was more easily discovered.

This fish is armed with a single sharp spine upon each opercular bone, and two upon the dorsal fin eight lines in length. Each spine has an aperture on its anterior surface just below the apex, and upon pressing back the integument in which it is enveloped nearly to its summit, a thick creamy fluid flowed or spirted from the aperture. Upon removing the integument with a dissecting knife a small sac or reservoir was exposed, attached to the opercular



THALASSOPHRYNE RETICULATA.

a a, The opercular spines. *b b*, The dorsal spines. *B d*, Opening in poison sac. *c c*, The mucous canals.

bone near its base, which contained the same creamy fluid which had previously been seen to exude from the aperture near its apex. On inserting a bristle into this aperture it reappeared at another opening near the base of the spine, and within the sac or reservoir already described. A tube leading from this reservoir was also detected, having a free end lying within the sac, and evidently being the canal by which the fluid was conveyed to this receptacle. There seems no doubt that this canal goes directly into a branch of the mucous system of

the fish, and that it is by the mucous glands that the fluid is secreted.* The dorsal spines were found to be furnished with precisely similar contrivances.

Nobody, says Dr. Günther, will imagine for a moment that this complicated apparatus can be intended for a harmless purpose, or to emit an innocuous fluid into a wound.

This example of a special poison-organ in fishes, although an isolated one, is, nevertheless, of the highest importance, as the muciferous system supplying these glands is common to the whole class of fishes, and though not quite clearly demonstrated by a good anatomical examination, yet there are doubtless many others which will have to be added to the number; and just as in the class of Ophidia, we have some snakes with poisonous saliva and some quite innocuous, so we shall also find it to be with the mucous secretion of fishes.

It must also be borne in mind that these fish-spines are merely weapons of defence; all the Batrachoids with obtuse teeth upon the palate and lower jaw, feeding upon mollusca and crustacea.

Explanation of Figure of Thalassophryne reticulata from the Pacific Coast of Panama, 1-4th Natural Size.—*a a*, The opercular spines seen projecting from the sides of the fish, just above the gill openings. *b b*, The dorsal spines. *c c*, The mucous canals, which traverse the entire length of the fish on each side. *A*. The opercular spine seen separately (natural size). The openings to and from the canal by which the poison is introduced into wounds are indicated by arrows. *B*. The same spine with the poison-sac or reservoir attached, showing (*d*) the small orifice by which the poison is conveyed to the sac from the muciferous system, with its free end lying within the sac.

* The two specimens of *Thalassophryne*, being distinct species, and at present the only existing types, have not been injected or dissected further to demonstrate this point, but more specimens from Panama are shortly expected, and when these arrive, injections of the glands will be properly made.

MOSSES TO BE FOUND IN MAY.—CORD-MOSSES AND APPLE-MOSSES.

BY M. G. CAMPBELL.

THE common cord-moss (*Funaria hygrometrica*), which crowns our walls and banks almost everywhere, feels the genial power of May, and hastens to ripen and pour out the little seeds that have been hitherto so snugly encased in its pear-shaped capsule, and whose mouth, obliquely placed, and turning towards the earth, seems conveniently ready for their exit as soon as the little trencher-like lid has fallen off, and the large dehiscing annulus has unrolled, which latter act takes place immediately on the fall of the lid.

It is true that every month in the year weaves its own moss-wreath, brings its own favourites to perfection, and that, therefore, many a change, many an operation of marvel and of beauty, is continually going on around us, and as continually lost to the casual observer. But we invite our readers to a microscopic examination of the genus *Funaria*, and especially *Funaria hygrometrica*, which is so easily procurable, as excellent examples of the structure and arrangement of the inflorescence and fructification of mosses in general. The *Funariæ* are named from *funis*, a rope, cable, or cord, in allusion to the twisting of the seta in this genus, giving the appearance of a twisted cord.

They are acrocarpous, sub-biennial and loosely cæspitose mosses, with a stem at first simple, and crowned by a barren discoid flower; subsequently they become branched, and terminate in fertile flowers, each producing a solitary capsule, obliquely pyriform, sub-ventricose, and of thick texture, with a mouth always more or less oblique, and often small, surrounded by a double peristome of sixteen divisions each; the outer consisting of sixteen oblique, lanceolate-tapering teeth, having numerous prominent trabeculæ on the inner side, and all connected at their apices by a small, reticulated, and circular disc. These teeth are also longitudinally marked with fine striæ, and have the property of being remarkably hygrometric, spreading outwards in drying after the rupture of the connecting membrane.

The inner peristome is, at its base, somewhat coherent to the outer. It is also divided into sixteen processes, placed opposite to the outer teeth, of a lanceolate form, and each marked with a medial or vertical line. The lid is conical or obtusely convex; the annulus, when present, large, and unrolling spirally, but in some species it is entirely absent. The leaves are of thin texture, consisting of large succulent, oblong-

hexagonal cells, or cellules, and even the nerve itself is loosely cellular, and it ceases at or near the apex.

In *Funaria hygrometrica*, or the common cord-moss, the perichætial leaves are connivent, ovate-lanceolate in form, concave, entire, nerved to the apex, and clustered together so as to form a sort of bud; the lower leaves are smaller, scattered, and more or less spreading, while those of the perigonium, or barren-flower, are denticulated both at the apex and at the base; they are of a sub-spathulate form, and have the basal margin recurved. The capsule is pyriform-incurved, strongly furrowed when dry, and having a very oblique mouth, which is surrounded by a beautifully corrugated border, not observable in any other species, and varying from deep yellow to orange or reddish as it ripens. The lid is plano-convex, with a red tumid or slightly frilled border, distinctly grooved for the lodgment of the large dehiscent annulus which unrolls spirally immediately after the lid falls away; thus, almost simultaneously, are removed two barriers to the exit of the spores, which are small, and of a reddish-brown colour. The seta, or fruit-stalk, is arcuate and flexuose, the upper part twisting to the right when dry, the lower in an opposite direction. In length it varies very considerably, from half an inch on the tops of exposed walls, to two and even three inches in more warm and sheltered situations. We have grown it under a glass, and found the seta attain to rather more than three inches in length. The outer peristome is reddish, the inner yellow.

There are three varieties of this moss. The variety *patula* has a more slender stem, branched, with spreading and somewhat undulated terminal leaves, which become twisted when dry. Variety *calvescens*, with the same kind of stem and leaves, but with a straight elongated fruit-stalk, and a more slender sub-erect capsule. We have seen some specimens brought from Switzerland which had grown to a very large size.

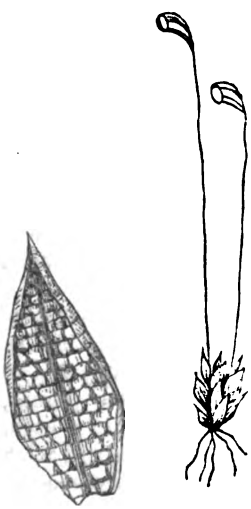
If, as we have already said, *Funaria hygrometrica*, so easily procurable, and so easily recognizable, be carefully examined for some months prior to the ripening of its capsules, it will give no very imperfect idea of the economy of this department of the vegetable world.

Previous to the appearance of the young seta at the tops of the infant shoots or stems will be seen small stellate flowers of a reddish hue. These are the barren flowers, answering to the stamens of what are called phænogamous, or flowering plants, and on dissection in water they will be seen to consist of a little cluster of vesicles of an oblong bladder-like form, mingled with jointed pellucid filaments, the first named *antheridia*, the second *paraphyses*, and these are surrounded by several rows of spreading leaves constituting the *perigonium*. The *antheridia* are

at first filled with a semi-gelatinous loosely cellular tissue, each cellule containing a spermatozoid, which consists of a spiral fibre, having attached to it a very small oval or roundish corpuscle, which is usually found near the middle of the spire. On the escape of the contents of these antheridia when mature, more or less of an explosive action takes place, and very soon after being launched into the water the spermatozoids begin to fidget, then to gyrate rapidly within the cells, and eventually bursting the walls of their cellules, they escape from confinement, and may be seen for several hours moving about in various directions in the water, as if wild with new-born joy at their escape from imprisonment.

Thus far we have treated of the barren flower only, but the genus being monoicous, the fertile flower may easily be found by dissection at the apex of a young shoot at precisely the same season, and on the same individual plant. This flower is composed of slender flask-shaped bodies, called *archegonia*, which are mixed with jointed filaments named *paraphyses*, and both surrounded by a little cluster of leaves, which stand erect, and which at length become the *perichætium*.

In length the *archegonia* somewhat exceed the *antheridia*, but they are much more slender, indeed filiform, except towards the base, where they appear slightly tumid, and at the apex, which is somewhat expanded, the filiform connection between the apex and the base being a canal in which is lodged a roundish vesicle, the nucleus or germ of the future capsule and its fruit-stalk; and the perfect archegonium soon becomes enlarged



and swells out by the increase in bulk of the vesicle within it, which at length rends it asunder by a horizontal fissure near its base. The upper part is then converted into the *calyptra*, and the lower becomes the *vaginula*, while the rudimentary vesicle itself is metamorphosed into a fruit-stalk, its tapering base inserted firmly into the vaginula, and having its apex sheathed by the embryo calyptra. This stalk or seta goes on increasing in length until it has attained its full height, until which time the apex remains, as it were, stationary, but then it swells out, and developes into the capsule. This capsule consists of a central pillar, or column, called the *columella*, surrounded by a membranous pouch or bag, called the *sporular sac* or membrane, within which the spores, analogous to the particles of

pollen in flowering plants, are safely lodged in rings of mother cells, till the period when they are ready to take an independent position in the field of nature. The layer of sporules being surrounded by the sporal membrane, which consists also of two rings of cells, the outer one containing green granules, the inner pellucid; and these are again surrounded by the thecal membrane, consisting also of two rings of cells, the inner tinged with green granules, the outer pellucid; the size of the space between these two membranes differing not only in different species of mosses, but also in the same species at different periods of growth, being in contact in some, as in *Orthotrichum diaphanum*, and in others, "of which *F. hygrometrica* and *Bartramia pomiformis* are," says Mr. Valentine, "the most marked examples; they are widely distant, this distance, however, constantly diminishing by the growth of the columella and the gradual development of the sporules;"* and over all is the *theca* or outer wall, whose cellules are slightly tinged with brown.

At this early stage the mouth of the capsule is closed up by the lid or *operculum*, and an intermediate coloured ring, the *annulus*, formed of large cellular tissue, which, affected by surrounding moisture, causes the lid to fall off, and disclose the beautiful peristome, whose hygrometric action regulates the escape of the ripened spores. The outer row of teeth in this double peristome is a fringy continuation of the *thecal* membrane; the inner, a like continuation of the *sporal* membrane.

Arrived at this stage of maturity, the short branch which bore the fertile flower has become much elongated, overtopping and concealing the barren flower, which will now appear to be at the base of the stem; and amid the cells of the theca, towards the base of the ripe capsule, may be discovered, by a good glass, those little stomata or pores, considered by Mr. Valentine as the necessary apparatus for the admission of air, in order to give greater firmness to the coats of the spores, and the better prepare them for germination. In the young state these stomatas are very small, and much less numerous than when the theca has arrived at maturity; and in *Funaria hygrometrica* we have one of the two exceptions mentioned by Mr. Valentine in the *Transactions of the Linnean Society*, vol. xviii. page 240, in the form of the stomata of mosses, as observed by him. He says:—"Of 103 British species of mosses which I have examined, 78 are furnished with stomata, their usual shape similar to the most common form in phænogamous plants," to which he adduces only two exceptions, *Funaria hygrometrica* being one, each of whose stomata consisting of a single cell in the form of a hollow ring, with the sides "so compressed as to convert the aperture into a mere slit."

* *Linnean Trans.*, vol. xviii. page 241.

We are not aware whether Mr. Valentine has fulfilled his hopes of turning these stomata of mosses to account in the arrangement of genera; and for ourselves we incline to prefer more obvious characteristics as the foundation of generic distinctions; because, though every trace of nature's workings must be teeming with interest and pleasure to the initiated, we would lay on no additional bolts and bars to impede the entrance of the uninitiated into this temple of wonders.

But we have dwelt long enough on *Funaria hygrometrica;* before, however, turning to the other two members of this genus which we will briefly describe, we would just remark that *F. hygrometrica* has received from the French the name of *La Charbonnière*, from its frequent occurrence on those parts of woods, heaths, and moors which have been charred by fire, or where anything has been burnt; it ought therefore to be a constant follower in the wake of the gipsy's camp.

In the two remaining Funarias the fruit-stalk is straight, *i.e.*, not arcuate, and the capsules destitute of an annulus.

In *Funaria Hibernica*, or the *Irish cord-moss*, the fruit-stalk throughout its length twists to the left when dry, and the capsule is shortly pyriform, with a convex and papillate lid; the leaves are ovate-oblong, spreading, sharply serrated, and gradually tapering to an acuminated point. It was originally found by Mr. J. Drummond on a chalky soil, near Cork, and has since been met with by Mr. Wilson, as mentioned by him in his *Bryologia Britannica*, on a limestone soil, near Matlock in Derbyshire, and also near Conway, North Wales. But, as he remarks, it is often confounded with *Funaria Mühlenbergii*, which strongly resembles it, but is somewhat less of stature, and which grows in similar situations, namely on calcareous banks, walls, etc., forming lax patches, with stems from one to three lines only in length, very simple, leafless in the lower part, and rooting only at the base. The lower leaves are somewhat spreading or reflexed, the upper ones more erect, larger than the lower, concave, widely ovate, and suddenly acuminated, not gradually as in *F. Hibernica*, and instead of being acutely serrated, the serratures are blunt; the capsule is still more shortly pyriform, smooth, sub-erect, somewhat constricted below the mouth when dry, and of a yellowish or reddish-brown colour. The fruit-stalk is about half an inch in length, and, as in *F. hygrometrica*, the upper part twists to the right when dry, and the lower part in the opposite direction; the lid too is furnished with a reddish border, and the outer peristome is of a bright red tint. The calyptra is yellowish, the spores are granular on the surface, and twice as large as those of *F. hygrometrica*.

All three are found in fruit in May, and *F. Mühlenbergii*

takes its name from Dr. Mühlenberg, its first discoverer, who met with it in Pennsylvania. There are three varieties of this moss, having slight differences in the leaves.

Of the Bartramieæ, or apple-mosses, *Bartramia pomiformis*, or the common apple-moss, already alluded to, and *Bartramia Oederi*, Oeder's apple-moss, both fruit in this month.

The generic appellation of this genus was given in honour of Mr. Bartram, an American traveller and botanist; and its English name is descriptive of its sub-spherical capsule, which greatly resembles a miniature apple, fresh when moist, and when dry, furrowed, like a withered winter fruit.

The apple-mosses grow upon rocks or upon the ground, in perennial turfy patches, bearing terminal fructification. Sometimes, but rarely, they are found on the bark of trees. They differ in their inflorescence, which may be synoicous, monoicous, or dioicous, and in their peristome, which is sometimes single, sometimes double, and sometimes entirely wanting; but the form of the capsule is so marked, that they can hardly be mistaken for any other. The rapture which we felt, now many years ago, on first meeting with some specimens of this exquisite genus will, we are sure, be a life-long joy.

B. pomiformis, or the *common apple-moss*, may be found on dry shady banks in a sandy soil, and one variety, with longer and crisped leaves and long slender branches, inhabits the fissures of sub-alpine rocks.

With densely tufted stems of a glaucous green, dichotomously branched, and varying in length from half an inch to two inches, *Bartramia pomiformis* has crowded leaves, more or less spreading, linear-lanceolate, narrow and tapering, the border tumid, with a double row of spinulose serratures; the nerve sub-excurrent, and in the dry state the leaves are somewhat crisped or tortuous. The barren and fertile flowers are contiguous; the fruit-stalk from half an inch to an inch long, bearing the sub-globular cernuous or inclined capsule, of a reddish-brown colour, and, as in all the genus, furrowed when dry; the lid is small and sub-conical; the peristome double, the inner shorter than the outer teeth, and sometimes having cilia, sometimes without.

Bartramia Oederi, *Oeder's apple-moss*, is also found on shady rocks, but chiefly on such as are calcareous and in a moist situation. It grows in soft, lax, extensive patches, of a dark green colour; its slender stems being beset with radicles, and reaching a length of from one to three inches; its leaves recurved, and spreading every way, shorter than in other British species, and not sheathing nor suddenly dilated at the base, lanceolote and sharply keeled, the margin recurved and serrated at the apex, and the nerve sub-excurrent. In the dry state the leaves are crisped.

The capsule is small and oblique, with a rather large mouth in proportion to the size of the fruit, the lid plano-convex, and the fruit-stalk short, scarcely half an inch in length.

Both these fruit in May.

*Bartramia ithyphylla,** or the *straight-leaved apple-moss,* grows on alpine and sub-alpine rocks, is common on the rocks above Greenock and on various mountains, both in Scotland and Wales; it has also been found near Todmorden, in Lancashire.

With rigid leaves of a bright yellowish green, subulato-setaceous, more or less spreading from a pale sheathing dilated base, "by which character, and the broad predominant nerve," Wilson says, "this species is easily distinguished from every other British species." The fruit-stalk is about an inch in length, and the leaves are straight when dry; hence its distinctive appellation.

Bartramia rigida, or the *rigid apple-moss,* is a dwarfish species, with very short slender and fragile stems, from two lines to half an inch in height, downy, of a red colour, and having dark reddish radicles. From the branches being fasciculate, and slightly recurved with crowded leaves, it grows in compact tufts. It is found on shady banks in mountainous situations in Ireland. The leaves are lanceolate, tapering upwards to a narrow point, erecto-patent, straight, and rather rigid, the margin reflexed and serrated, rough on the back, with small roundish prominences or glands, which also cover the strong excurrent nerve. The areolæ of the leaf have an oblong-quadrate form. The fruit-stalk is about three-quarters of an inch in length, of reddish hue, and bearing the comparatively large sub-spherical capsule, which is at first oblique, but subsequently cernuous, of a reddish brown, and strongly furrowed when dry. A double peristome surrounds the mouth, the outer teeth of a reddish brown, and rather short, the inner still shorter and sometimes deficient or rudimentary. The lid is convex and apiculate; the spores are reddish, partaking of the general hue of the plant, and the inflorescence is monoicous; the barren and fertile flowers approximating; and the fruit ripens in September and October.

Bartramia fontana, or the *fountain apple-moss,* grows in wet places, especially near springs, as the name implies, and is found chiefly in mountainous countries. It has elongated stems, from one to six inches long, or even more, downy, with blackish or reddish radicles, and matted together in dense, extensive, yellowish or glaucous-green patches, the branches variously ramified, slender or robust, sometimes fasciculate and erect, sometimes disposed in a stellate manner; the leaves dimorphous, either ovate-acuminate, short and appressed to

* From ἰθὺς, placed upright, erect, or straight, and φυλλὰς, foliage.

the stem, or longer, and lanceolate, spreading, or secund, obscurely plicate at the base, bluntly toothed or serrated, and having the margin recurved below, with a sub-excurrent nerve, which sometimes ceases below the apex. The leaves are also papillose at the back, and those of the principal stem are broader than those on the branches. The capsule is of thick texture, and large size, of a reddish-brown colour, curved, and longitudinally furrowed when dry; the teeth of the outer peristome are closely barred, and the inner furnished with cilia, bundled two or three together. The fruit-stalk is long and of considerable tenacity. The spores are rather large and reddish; the inflorescence dioicous, the inner leaves of the perigonium obtuse and horizontally spreading from a broad concave base, the nerve so very faint as to be visible only with difficulty and always ceasing below the apex.

There are several varieties: variety *alpina* has short robust stems, with densely leafy branches, of an ovate-lanceolate form, mucronate, and having shorter fruit-stalks. Variety *falcata* has yellowish falcato-secund leaves, with a thick reddish nerve, and having the branches curved at the apex. Variety *pumila* has very slender short stems, with small narrow leaves, and a small capsule.

The inflorescence is dioicous and it fruits in June.

Bartramia calcaria, the *thick-nerved apple-moss*, has also a dioicous inflorescence, and grows, too, in wet places, but seems confined to limestone districts, and has longer and more rigid leaves than *B. fontana;* they are also less papillose, have a stronger nerve, larger areolæ, and the margin is not recurved: the perigonial leaves also differ considerably, being tapering to a very acute point, and nerved to the apex, while the teeth of the peristome, instead of being closely, are but remotely, barred. It has been found in the Highlands of Scotland, near Todmorden, in Lancashire, and at Hale Moss, in Cheshire. Its fruiting season is July, and it grows in dense patches of a more intense green colour than *B. fontana.*

In *Bartramia Halleriana, Haller's apple-moss*, the inflorescence is monoicous, the stems are somewhat elongated, from one to three inches in height, with irregular, but fastigiate branches, *i.e.*, the branches, wherever they begin, all reach an equal height. It forms soft, lax tufts, of a bright yellowish green colour, but as the stem descends it becomes covered with radicles of a rich brown tint. The long slender leaves are linear-subulate, and seem to spread in every direction from an erect dilated, slightly sheathing base, which is pale, and somewhat shining—sometimes however they are sub-secund; they are roughish on both sides, serrulate at the margin, and are tortuous or crisped when dry. The fruit-stalk is very short,

not as long as the leaves, only about two lines in length, curved, and seeming to be lateral, in consequence of the growth of innovations, which are usually solitary; but the flowers, when examined at an early stage, are always found to be truly terminal. The moss is an inhabitant of alpine and sub-alpine rocks, and fruits in June and July, sometimes bearing two or three capsules together.

Bartramia arcuata, or the *curve-stalked apple-moss,* strikes us, at first sight, as an exaggeration of *B. Halleriana,* with red fruit-stalks, which, though longer, are still short and arcuate, being only about twice or thrice the length of the capsule, which hangs sub-pendulous upon it, and, as in *Halleriana,* have the appearance of being lateral from the same cause, namely, the growth of innovations. It, too, grows in extensive yellowish-green patches, but the stems reach from two to four inches in height, densely covered with reddish-brown radicles, and the leaves, which are plicated, are of an ovate-lanceolate form, shining, sheathing and erect at the base, thence widely spreading, with a nearly plain serrulate margin, and an excurrent or sub-excurrent nerve. It grows on moist heaths and on the rocky banks of streams in hilly places, forming dense masses; and though its rich golden globular capsules are rarely met with, its bright yellow-green foliage contrasts agreeably with the downy fuscous radicles that so thickly clothe the lower part of the stem, and this contrast renders it a most attractive object even in the barren state. Its fruiting season is September and October, two or three months later than *B. Halleriana,* and it may be met with on the Sidlaw Hills, above the village of Auchterhouse, in fruit; it is also said to be abundant at Lodore Waterfall, near Keswick, and in fructification at Lidford Fall in Devonshire, and at Cromaglonn, near Killarney, Ireland; also sparingly in fruit near Llyn Ogwen in Carnarvonshire.

Another species, *Bartramia cæspitosa,* hitherto considered Swedish, has lately been found by Mr. Wilson, in a new marsh near Warrington; but not having seen a specimen, we are unable to describe it.

Bartramidula Wilsonii, or the *beardless dwarf apple-moss,* is a most beautiful little plant, somewhat resembling *Bartramia fontana* in miniature, but its exquisite little pink capsules are sub-pendulous or quite pendulous, and hang on reddish arcuate fruit-stalks, often three or four together, and resembling full short pears rather than apples in outline, are smooth, shining when dry, with thin, somewhat pellucid walls, which are of soft texture, slightly rugose in the dry state, but not striated, and having a small mouth destitute of peristome, and closed with a small sub-conical lid, which is again surmounted by a small,

cuculate, but very fugacious calyptra. The vaginula is oblong, and the spores are reddish, granular on the surface, and, notwithstanding the diminutive stature of the moss, its stems scarcely reaching half an inch in height, they are even somewhat larger than the spores of *Bartramia fontana*. The branches are fascicled, two, three, or more together, and sub-erect; the leaves ovate-acuminate, or lanceolate-acuminate, slightly secund and sub-erect, the nerve reaching nearly to the apex, or sometimes excurrent; they are finely serrated in the upper part, and are composed of rather lax oblong cellules. The fruiting season is October, and it has been found growing in different localities on the mountains of Scotland, Wales, and Ireland; but Mr. Wilson says, "It has not yet been observed in any other country, and is liable to be overlooked on account of its diminutive size."

Of the two other species of apple-moss, *Catoscopium nigritum*, or the *lurid apple-moss*, is somewhat allied in habit to the *Bartramia*, but Bridel and Wilson make a separate genus for it, named κάτω from *down*, and, σκοπέω to *look*, in allusion to the appearance of the capsule, which suddenly bends forward, as if looking down from the top of its seta, or solitary elongated pedestal. It is small, roundish, smooth, shining, and of a thick texture, almost horny, with a rather oblique mouth, destitute of an annulus, and having a small conical lid, which covers a single peristome of sixteen short, lanceolate, or truncate teeth, transversely barred, irregular, and marked with a medial line, which leads one to suspect that, as in some other mosses, it may be the junction of two teeth cemented, as it were, into one; sometimes, also, obscure traces of an inner peristome may be discovered. The spores are comparatively large and smooth; the calyptra small, shaped like a little hood, smooth, and usually fugacious, though occasionally found remaining on, or rather adhering to the fruit-stalk beneath the capsule, which, when mature, is black, hence its specific name.

The inflorescence is dioicous, with terminal flowers; the leaves lanceolate, carinate, nerved, somewhat recurved, and spreading; the areolæ small, quadrate, and opaque, and though the species is rare, being found only in a few places, it is perennial in its native habitats, which are moist alpine rocks, or subalpine marshy places. It is plentiful on Ben-y-gloe, near Blair, in Athol, and we have seen specimens brought from the sands of Barrie, on the coast of Forfarshire—a circumstance which goes to prove what has been often asserted, namely, that the climate of the lofty mountain and that of the seashore are very closely allied, and the sight of this little tenant of the mountain wild, and of the lowly beach, ever brings with it associations both pleasing and sublime. It grows in soft green tufts, the

stems varying in height from two to six inches, or even more, slender, almost filiform, flexuose, and beset with reddish brown radicles in the lower part.

The only remaining example is the *naked apple-moss, Discelium nudum,* to which also a separate genus is given, named from δις, *twice* or two, and σκηλος, a *leg,* because the teeth are split into two divisions from the base to the middle, giving the appearance of legs. They are also jointed. *Discelium nudum* is the only known species of this singular genus, which seems to combine in itself some of the attributes of three others; for example, it resembles *Catoscopium* in its capsule, *Phascum* in its mode of growth, and *Trematodon* in its peristome. Like the Phascums, it is almost stemless, and, like them, grows from a conferva-like thallus, which in *Discelium* has a green velvety appearance; the leaves are few and imbricated, concave, entire, ovate-lanceolate, and almost destitute of nerve; the areolæ lax, oblong-hexagonal, and diaphanous. Their number is about six or eight, and they seem to be solely or chiefly a gemmiform envelope for the inflorescence. When old they are of a pale reddish hue, and the green velvety thallus withers and becomes discoloured soon after the formation of the fruit; and frequently by the action of the frost in winter it decays and mixes itself with the mould of the substratum, even before the ripening of the capsules, which does not occur till February or March. The capsule is sub-globose, as we have already said, resembling Catoscopium, but is reddish in colour, and more or less cernuous; the lid, however, is large, conical, and more or less acute; the annulus, too, which is sub-persistent, is large, composed of a double row of cellules; the vaginula oblong, not much thicker than the fruit-stalk, which latter is about an inch long, reddish, and flexuose; the calyptra is narrow, smooth, and subulate, and splitting on one side throughout its whole length, the fissure ascending spirally. Like that of Catoscopium, it is fugacious, or when entire at the base, which is frequently the case, being longer than the fruit, it remains attached to the fruit-stalk beneath the capsule. The spores are of moderate size, punctulate and reddish.

The favourite habitats of the species are the clayey declivities of the North of England and Scotland. It was first discovered by Mr. George Cayley near Manchester; Mr. Don also found it by the side of the river Tay near Perth; and it has since been met with in several places, especially in the neighbourhood of Manchester, turning the vicinity of that busy scene of manual labour into classic ground for the botanist and the lover of nature's most lovely forms, and linking it with associations and recollections, apart from the every-day turmoil of the struggle for existence.

MOLECULAR MOTIONS IN LIVING BODIES.

BY HENRY J. SLACK, F.G.S.,
Member of the Microscopical Society.

BEFORE suggesting inquiry into the part which molecular motions perform in the growth and decay of living organisms, I shall endeavour to make the subject more generally interesting by a few preliminary observations, which may assist those to whom it is entirely new.

In order to know what molecular movements are, a small drop of water should be placed on a glass slide, just touched with a fine camel-hair brush whose point has been dipped in gamboge, then covered with a thin glass, and viewed with a ¼ objective and second eye-piece, or with a higher power, if one is at hand. The scene disclosed to the eye is singularly striking when first observed, and may be frequently seen without losing the interest it originally inspires. Thousands of little round particles are perceived to keep up an active fidgetty motion, sometimes approaching, sometimes receding, rolling, quivering, shaking, and comporting themselves not unlike a swarm of live creatures suddenly frightened and not at all clear what they are about. If the water does not evaporate, the spectacle may be watched for hours, until, at length, it usually happens that the particles adhere to the glass, and quiet is restored.

The French call these movements "Brownian," after their discoverer, the famous English botanist, and they may be produced with any material not soluble in water, provided the size of the particles is proportioned to their own specific gravity and to that of the fluid. What is required is, that the particles shall be freely *suspended* in the liquid, and be of minute dimensions. Substances of nearly the same specific gravity as water will have little tendency to rise or fall, and that tendency is easily controlled, for a time, by reducing them to a moderate degree of fineness. The particles of the water cohere with a certain force, so that a greater force is necessary to make any substance move either upwards or downwards in that fluid. It is more easy to move through a light fluid than a dense one. Fresh water, for example, opposes less resistance than salt. Every bather has noticed the difference between trying to touch the bottom in a river and in the sea, while Dead Sea water is so heavy as to make swimming an easy task for an animal not specifically heavier than a man. In like manner limpid fluids oppose less resistance than sticky ones; and an insect that can move easily through water, is sadly impeded when immersed in glue.

When any insoluble body is pressed under water, it displaces its own bulk of that fluid. If it is lighter than that bulk, it is forced up, and floats. If heavier, it is forced down by gravitation, and sinks. But although the specific gravity of a substance is greater than that of water, it will still float, provided its surface is extended, so that the resistance of the water, arising from the cohesion of its particles, is made equal, or more than equal to, the weight of the substance, or force, with which it gravitates. Thus a film of gold leaf will float, while the same weight of gold in a pellet falls fast. From these facts it results that in order to cause a heavy metal like gold or platina to be suspended in water, with little tendency to fall, its particles must be reduced to such a degree of fineness that their *weight* is nearly counterbalanced by the resistance which the fluid offers to the passage of their *bulk*. This can be accomplished more easily than might be expected, because the weight of round bodies diminishes much faster than their size. The rule is, that the contents of spheres are as the cubes of their diameter, so that if a ball three inches in diameter weighed 27, another ball one inch in diameter would only weigh 1. Thus a moderate reduction in the size of a round particle makes a great deal of difference in its weight.

When a minute particle is freely suspended in a highly mobile fluid like water, the slightest force of any kind will disturb its equilibrium, and impart some motion; but exactly what force causes the molecular movements does not appear to have been ascertained. Dr. Carpenter gives an interesting summary of what is known, in his work on the Microscope, from which we will make a quotation. He says:—

"Nothing is better adapted to show it (the molecular motion) than a minute portion of gamboge, indigo, or carmine, rubbed up with water, for the particles of these substances that are not dissolved, but only suspended, are of sufficiently large size to be easily distinguished with a magnifying power of 250 diameters, and are seen in perpetual locomotion. Their movement is chiefly of an oscillatory kind, but they also rotate backwards and forwards upon their axis, and they gradually change their places in the field of view. It may be observed that the movement of the smallest particles is the most energetic, and that the largest are quite motionless, while those of intermediate size move but with comparative inertness. The movement is not due, as some have imagined, to evaporation of the liquid, for it continues without the least abatement of energy in a drop of aqueous fluid that is completely surrounded by oil, and is therefore cut off from all possibility of evaporation; and it has been known to continue for many years in a small quantity of fluid enclosed between two glasses in an air-

tight case. It is, however, greatly accelerated and rendered more energetic by heat; and this seems to show that it is due either directly to some calorical changes continually taking place in the fluid, or to some obscure chemical action between the solid particles and the fluid, which is indirectly promoted by heat."

The *Micrographic Dictionary* states "that neither light, electricity, magnetism, nor chemical re-agents exert any effect upon it;" but it may perhaps be worth while to verify these assertions.

After witnessing the molecular movements with gamboge, as recommended at the beginning of this paper, let two minute drops, one of water and the other of gum water, be placed near each other on a slide. Put a little gamboge into the water-drop, and then cover both drops with a light thin piece of glass. The two drops will mix slowly, and it is then easy to see the gradual effect of the introduction of the gum in arresting the motion, by diminishing the mobility of the fluid. To see the effects of heat, place the microscope upright, lay a thin strip of sheet zinc on the stage, having a little hole cut in it, and long enough that one end shall project an inch or two beyond the stop on one side; then place a piece of thin glass over the hole in the zinc, put a drop of gamboge water upon it, cover with another thin glass, place a spirit-lamp under the projecting part of the zinc plate, and watch the result as the heat is conducted to the fluid and its contents. The heat gives rise to currents in the water-drop, and the additional motion thus imparted—one of distinct translation in a given course—must not be confounded with the peculiar molecular fidget which will go on with accelerated velocity at the same time.

FIG:1.

x 1000.

Passing from instances of molecular motion in water-drops, it is interesting to watch it in living bodies. In the cells of confervæ it may be frequently met with, and it is probably concerned in the so-called "swarming process" of desmids and other simple plants. When the chlorophyl of conferva cells is undergoing decay, the molecular movements may be continually seen; but it is not every mode of decay that breaks up the larger masses into the little particles convenient for its exhibition. Fig. 1 represents its appearance, so far as stationary dots can indicate it, in a common conferva, and I have seen it conspicuously shown in the cells of a moss often found in ponds—*Fontinalis antipyretica.*

Although frequently associated with decay, it apparently also forms part of the series of operations that take place in

healthy cells, and I think it is exhibited in many of the conditions under which the protoplasm of plants is engaged in forming new organs, as well as in other cases in which previously existing forms are being taken to pieces. In a physical point of view, all that is required is the presence of molecules of the right size, in proportion to their weight, in a fluid of suitable density, and not too viscid.

The higher the power employed, the more extensively this kind of motion can be traced. With my $\frac{1}{50}$th I have seen it well displayed in extremely minute vacuoles of ciliated infusoria, and recently was much struck with it in blood corpuscles taken from the gills of tadpoles in an early stage. I believe I am right in stating that true blood corpuscles result from embryonic or primary cells, differing considerably from perfect blood corpuscles either white or red. In my tadpole babies the particles circulating through the gills in close, chain-like array, presented, when immersed in water, instead of the characteristic reptilian form, the appearance of Fig. 2, and all the little particles represented by the engraver's dots, were in strong molecular motion, which I presume to be connected with the process of development. White nucleated corpuscles are gradually formed, giving rise, in their turn, to the red.

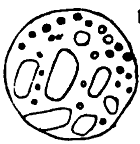


FIG: 2.
× 1000

The molecular motions must tend in living vessels, as they do in pails or jugs, to prevent a fluid from clearing by the sinking down of small suspended matters. They must also promote any chemical and physical action between the fluid and the particles which are continually rubbing themselves against it, and they may thus perform an important function in the processes both of vital construction and decay.

I append to these brief notes a few extracts from two very important papers by Professor Lionel Beale, which appeared in the January and April numbers (1864) of the *Quarterly Journal of Microscopic Science*:—

MINUTE PARTICLES OF GERMINAL MATTER IN THE BLOOD.

"In the blood of man and the higher animals a great number of minute particles, of the same general appearance and refractive power as the matter of which the white blood corpuscles are composed, may be demonstrated. Some of these particles probably, under certain conditions, grow into ordinary white corpuscles, while others, after increasing to a certain size, become red blood corpuscles.*" Dr. Beale adds that both

* *Quarterly Journal of Microscopic Science*, April, 1864, page 48.

white and red corpuscles vary much more in size than is usually supposed.

FOUR KINDS OF MATTER IN THE BLOOD.

"In the blood we have—1. Matter that is living and active. 2. Matter that has ceased to live, and which now possesses peculiar properties and chemical composition. 3. Matter which results from the disintegration of the formed material; and 4. Matter (pabulum) which is about to live, or about to be converted into living matter. . . . . I believe the colourless corpuscles, and the colourless nuclei of the red corpuscles, consist of matter in a living state, while there are reasons for concluding that the coloured material has ceased to exhibit vital properties."*

SHAPE OF BLOOD CORPUSCLES.

"If the oval corpuscles of a frog be left at rest in a fluid of about the same density as themselves, they become completely spherical, and a similar change occurs in the oval blood corpuscles of all animals that I have examined." †

THE PHOSPHATES USED IN AGRICULTURE.

BY DR. T. L. PHIPSON, F.C.S. LONDON, ETC.

It is now some twenty years since the great truth of the gradual exhaustion of soils by continued cultivation began to dawn vividly, and with all its force, upon the agricultural public of Great Britain. Numerous analyses of soils and plants, undertaken, in the first instance, to satisfy an ever-increasing curiosity, soon demonstrated, in a most forcible and practical manner, the nature of the ingredients which our crops take yearly from the soil, and which, in a country so thickly populated as England, it is indispensable to restore in some way or other to the soil, in order to keep up a proper degree of fertility.

The art of *manuring*, practised for centuries before, began to be understood within the last quarter of a century only; and though the labours of Liebig in Germany, and Boussingault in France, preceded by those of Sir Humphry Davy in this country, have contributed not a little to our present knowledge of the subject, yet in no country have the influences of science been so considerable, so gigantic, as in our own. The reason of this, doubtless, lies in the actual population of Great Britain, of which the average to the square mile is greater

* *Quarterly Journal of Microscopic Science*, January, 1864, page 34.
† *Ibid*, page 34.

than that of any other country; consequently, the soil here is caused to do its utmost, and the effects of exhaustion have been sooner and more keenly felt. Although scientific agriculture, as regards its diffusion among the people, is still in a deplorable state on the continent of Europe, as may be seen by glancing from time to time at the periodical literature of Belgium, France, Germany, and Italy, the time will certainly come when the art of manufacturing and applying manures of all descriptions will be as actively pursued in these countries as in England at the present day.

Three of the more important ingredients which soils lose by cultivation, and which it is necessary to restore to them in greater or smaller quantities, are potash, nitrogen, and phosphate of lime. Nature herself supplies these substances to the soil in various ways, and in quantity sufficient for the growth of wild plants. Thus, potash is washed into the soil by the rain-waters which flow over granitic and felspar rocks, so that every little stream contains some of it; nitrogen, in the form of ammonia, is constantly present in the atmosphere, and phosphate of lime is very widely distributed over the globe. Moreover, the excrements of animals contain all three. Another ingredient very essential to vegetable life is carbonic acid, of which there is so large a supply in the atmosphere, in the streams, and rocks of the globe, that it is rarely necessary to supply it artificially to our cultivated crops.

I have said that nature supplies a sufficiency of these more important constituents of the fertile soil, to ensure the growth and luxuriance of wild plants. But in agriculture we are dealing with an artificial state of things, and the natural supply no longer suffices to maintain fertility in our cultivated soils. In our present system of manuring potash is supplied by farm-yard manure, sometimes by wood-ashes, and by manures made by drying the excrements of animals (sewage, etc.) The first and last of these supply also ammonia and phosphates. Our chief sources of nitrogen are Peruvian guano, nitrate of soda, and sulphate of ammonia (from the gas-works). The first of these supplies, at the same time, phosphate of lime, and the last is sometimes introduced into artificial manures, such as the ammoniacal superphosphates.

Our sources of phosphate of lime are most numerous, and it is to these alone that I shall devote the present paper. A few years ago, all the phosphorus used for the manufacture of lucifer matches was extracted from bones, the phosphate of lime used in the various manufactories was likewise obtained from bones. These were principally collected in the streets and waste places, at butchers' establishments, etc. Since the manufacture of *superphosphate of lime* began for the use of the

farmer, not only immense quantities of ox bones have been imported yearly into England from South America and other countries, but a large number of natural deposits of phosphate of lime have been discovered and utilized without delay in the interests of agriculture and manufactures. It was shown by Liebig that it was of little use to supply ground bones to the soil in order to obtain a rapid result, for the bone earth takes a long time to become soluble by the action of the carbonic acid, and other vegetable acids of the soil, and cannot penetrate into the tissues of plants until it is so dissolved. In order, therefore, to furnish plants with phosphate of lime in a soluble state, Liebig proposed that bones or other phosphates should be treated with sulphuric acid. Hence arose the manufacture of superphosphate or soluble phosphate of lime, which has, of late years, taken such extension in England. It is to this manufacture principally that is owing the enormous importations of phosphate of lime in various forms which arrive in Great Britain from all parts of the globe.

It was probably the introduction of guano from South America that brought certain practical minds to consider more attentively the best means of restoring fertility of exhausted soils and of keeping up the fertility of those not yet exhausted. This extraordinary and powerful manure, the enormous supplies of which appear to have been stored up by Providence for the actual wants of agriculture, as the endless supplies of coal have accumulated in bygone ages to supply the wants of our manufactories, was brought to Europe in 1804 by Alexander von Humboldt as a *scientific curiosity*. Its valuable nature was not entirely appreciated by the public at large until about 1838, when large quantities of it began to be imported into England as a manure. Two years later (1840), Liebig brought out his well-known work on agricultural chemistry, making known the principle of the manufacture of superphosphate of lime, and in 1842, Mr. Lawes began to manufacture this superphosphate manure.

Guano being, as is well-known, the accumulated excrement of sea-fowl (and, consequently, having the same composition as the excrements of pigeons and other domestic birds), is abundant in many parts of the globe. In certain tropical regions (Peru, Chinca Isles, etc.), where it never rains, this guano is very rich in urate, oxalate, and phosphate of *ammonia*, besides containing about 22 or 23 per cent. of phosphate of lime. But in localities which are frequently visited by hurricanes and much rain, the *organic* constituents and salts of ammonia are washed out, and the *mineral* constituents increase in proportion: the guano becomes less valuable as a manure, by loss of its ammoniacal compounds, but constitutes a plentiful source of phosphate

of lime. Such are the phosphates known as "West India phosphate," "Bolivian guano," etc. These contain from 40 to 60 per cent. (and sometimes more) of ordinary phosphate of lime, whilst their per-centage of nitrogen (ammonia) dwindles down to 2, 1, or even 0·5 per cent., as the phosphate increases. Here, then, is an abundant source of phosphate of lime.

But several West India islands furnish a species of hard rock, of very peculiar aspect, consisting chiefly of phosphate of lime. Many persons consider that this rock has been derived from guano, supposing it to be the result of exposure to the atmosphere for thousands of years; others imagine it to be guano modified by volcanic action. I have examined this mineral phosphate,* and find that it contains not only phosphate of lime, but also a considerable proportion of phosphate of alumina—a substance not met with in guano: it is, in fact, a compound of phosphate of lime and phosphate of alumina, containing about 17 per cent. of the latter, and 65 per cent. of the former. As this rock is principally derived from the little island of Sombrero, I called it *Sombrerite*. This is another tolerably abundant source of phosphate of lime, much used in the manufacture of superphosphate manure.

Another hard phosphatic rock, of a similar description, is found upon Monk Island, in the Gulf of Venezuela. Although I have received for analysis in my laboratory many hundred specimens of the different phosphates mentioned in this paper, I have never yet met with this one from Monk Island; but I have reason to believe it is a substance similar in all respects to Sombrerite. Whether it be so or not cannot be determined by the few incomplete analyses that appear to have been made of it hitherto. However, it constitutes a cheap source of phosphate to manufacturers of superphosphate manure; and it appears to contain 78 to 80 per cent. of phosphate of lime.

Another, and most abundant source of phosphate of lime is, I am happy to say, an indigenous one, and one which is very extensively utilized in the manufacture of superphosphate. I allude to the Cambridge and Suffolk *coprolites*. These are hard nodules, somewhat cylindrical, and having rounded edges. The Cambridge coprolites are found in the upper green sand, where they form extensive deposits, and are so intimately mixed, on their surface, with the green sand itself, that their true colour is only seen when they are broken. They contain 60 to 65 per cent. of phosphate of lime, sometimes rather more, and when ground form a yellowish-white powder. They are supposed to be the fossil excrement of extinct animals, hence their curious name, derived from the Greek; but we have not

* *Journal of the Chemical Society*, 1862.

sufficient proof of this extraordinary supposition. However, the revelations of geology during the past twenty years have been so exceedingly wonderful, that one is readily tempted to admit that some of these coprolites are the fossil excrement of certain extinct animals, probably reptiles, and therefore correspond somewhat in their chemical composition to guano which has been deprived of its organic matter by atmospheric influences. Specimens of such guano have given me, upon analysis, from 15 to 30 per cent. of *carbonate* of lime, which resembles the proportion of carbonate of lime invariably present in every description of coprolites.

The main thing that regards the agriculturist or manure manufacturer, however, is their chemical composition, by which these Cambridge coprolites appear to be the cheapest source of phosphate of lime at present known. The Suffolk coprolites are dark brown nodules, some of which have very much the appearance of fossil bones rounded by the action of the sea. They always contain a certain amount of red oxide of iron, and about 56 per cent. of phosphate of lime; they are consequently rather less valuable than the pure Cambridge coprolites; moreover, they appear to belong to the tertiary formations.

All these coprolites, and, indeed, all natural phosphates used in agriculture, except apatite (see further), contain a certain amount of carbonate of lime and insoluble silicious matter, and it is important to manufacturers and agriculturists to have the proportions of these determined accurately, otherwise they have no control over adulteration, and no basis to work upon in the manufacture of artificial manures.

Along with Cambridge coprolites I have found fragments of fossil bone—bones of reptiles, probably—showing the same chemical composition as the rounded nodules or coprolites themselves. The Suffolk coprolites appear to be chiefly fossil bone, more or less impregnated with phosphate of iron, etc.

But the whole of the Upper Green Sand formation of England is characterized by a wide diffusion of phosphoric acid in the shape of phosphate of lime. My attention was called to this some years ago, by a relation who forwarded to me a very large specimen of fossil wood from the Green Sand of the Isle of Wight, which, upon being submitted to analysis, gave me an enormous proportion of phosphate of lime—in fact, it was chiefly formed of this substance and fluorspar—though it was not apatite;* and I learnt afterwards that Mr. Thomas Way had formerly examined several fossil polyps, sponges, etc., from the Green Sand, which gave a very large per-centage of phosphate of lime.

* See *Report of British Association*, 1861, and *Chemical News*, 1861.

This proves to us that a great amount of phosphates has been diffused through the Upper Green Sand formations, may-be by the accumulated excrement of myriads of fish and large reptiles which inhabited this country at the remote geological periods to which these formations belong.

I have since analyzed many other sedimentary rocks and fossils, in order to discover whether they contained any notable quantity of phosphate of lime, but rarely found more than one or two per cent., frequently a mere trace only. However, there exist, doubtless, other sources of phosphate yet to be discovered.

If we admit that the mineral phosphate Sombrerite and that of Monk Island be similar minerals, and have been derived, by some unknown geological process, from guano; if we admit, moreover, that the coprolites found in Cambridge and Suffolk are, like those of the Coal and Lias formations, true fossil excrements, mixed here and there with bone; and, thirdly, if we admit that the other numerous and above-named fossils (wood, sponges, polyps, etc.) fossilized by phosphate of lime, be the result of an impregnation of organic substances by the excrementitious matter of animals now extinct, what a splendid example we have here of *applied palæontology*. For since agricultural chemistry began its rapid development, all these "fossil excrements" have become valuable as a means of aiding us to keep up the fertility of our soils, to increase our wheat crops, and to have an abundant and cheap supply of bread. We are thus tempted to class all phosphates used in agriculture, including bones, bone-ash, etc., as derived from organized beings that have once flourished upon our globe.

But we have another source of phosphate of lime in the coarse variety of apatite of Estremadura, which appears to have had no connection with organized beings of any description, and cannot be considered as a fossil. The Estremadura phosphate met with in commerce is the mineral apatite in the massive form; it is abundant in Spain, and may be in other countries also, but up to the present time it does not appear to be so plentiful as the other phosphates mentioned in this paper. However, it is of all known substances found in nature that which contains the most phosphate of lime, the per-centage of which in the commercial specimens averages from 85 to 87 per cent., and in absolutely pure specimens as much as 92.

The remaining phosphates used in agriculture are bones, bone-ash, and animal charcoal. The two latter are merely burnt bone. Bones contain the peculiar phosphate known as "bone-earth," equivalent to about 56 per cent. of ordinary tribasic phosphate of lime. When ground, they often become mixed with silica and other impurities. Enormous cargoes of ox-

bone, either sun-dried or in the shape of bone-ash, are imported from South America into England.

Bone-ash is bone burnt *in contact with the air* until its organic matter is destroyed; it yields a quantity of bone phosphate equivalent to 70 or 90 per cent. of ordinary phosphate of lime, according to its degree of purity. When burnt *without contact of air*, animal charcoal is obtained; this is used to clarify sugar, juice, etc., and when spent is burnt over again. After being thus burnt twice or thrice, it becomes comparatively useless to the sugar-refiners, and is sold to manufacturers of superphosphate. According to a number of analysis made of this substance in my laboratory, it may be said to average from 70 to 80 per cent. of phosphate of lime.

Such, then, are the substances which furnish our agriculturists, our lucifer-match manufacturers, our colour-makers, etc., with their supplies of phosphate of lime. It is needless, perhaps, to add that agriculture absorbs by far the greatest portion of this phosphate, and we may be thankful that there exists so plentiful a supply of it. In a future paper I will consider our present sources of ammonia.

SNOW CRYSTALS.

BY E. J. LOWE, ESQ., F.R.A.S., ETC.

When we observe the snow beating against our windows, or being drifted into heaps by the wind, we regard it with interest, we admire its dazzling whiteness, and we are thankful to look upon its carpet, because it is a protection to tender plants from the injuries of severe frost. Few of us, however, are aware of the exquisite beauty of some of these snow crystals; very various in form, and sometimes exceedingly intricate, it becomes impossible to do justice to a snow-storm. The difficulties to be overcome are great: a lovely star descends and alights upon a leaf; paper and pencil are at hand, and the magnifying-glass reveals its beauties, but before it can be sketched in all probability it has melted and gone. If snow falls in showers, and the temperature of the air is above the freezing-point, it is almost impossible to sketch the crystals. Once or twice a year the weather is sometimes favourable for these investigations, and such a day was February 10, 1864. Let us take this day as an example:—

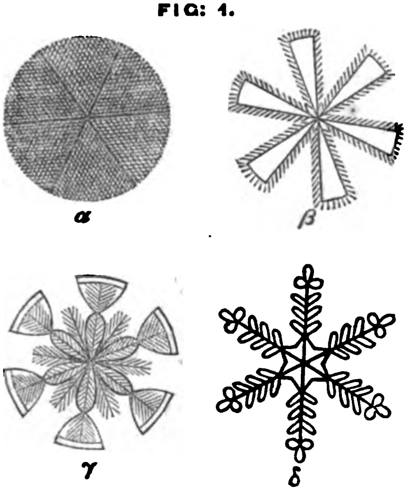
There had been a severe frost, the temperature falling to 15·8° at the height of four feet, and to 13·1° on the grass. The morning was overcast, foggy, dark, and having a peculiar yellow

smoky appearance, that is not uncommon on the advent of snow. At 9h. 15m. A.M. few snow crystals commenced falling; at 10h. 30m. A.M. the temperature at four feet was 25·8°, wet bulb thermometer 25·3°; on the grass, 24·7°; whilst, if we turn to the internal temperature, we shall observe that *below* the surface—

At two inches on drained land it was				25·8°
At four	,,	,,	,,	22·3°
At six	,,	,,	,,	20·8°
At two inches on undrained land it was				22·8°
At four	,,	,,	,,	20·5°
At six	,,	,,	,,	20·8°

The ground and air were, therefore, in such a condition that the snow would not melt. At first the snow crystals were solid, opaque, rounded, and confused in the interior, yet exhibiting the usual six-sided or hexagonal form. Amongst these crystals Fig. 1 *α* was detected, resembling six small feathers fastened together, and presently another, Fig. 1 *δ*, not unlike an arrangement of fern fronds, having a central opaque star. From this time (10h. 15m. A.M.) the crystals were most beautiful. A third, somewhat similar to the last-mentioned, yet having the branches transparent and six-sided; then came a solid flat lozenge.

FIG: 1.



The next crystal is more especially worth notice, as it was changed artificially. It is represented in Fig. 2 *α*, fern-like at the tips, but feathered within in the manner of a fir branch, *quite opaque* and snowy white; on breathing gently on this crystal it partially melted, and froze again as a colourless *transparent* six-rayed star, Fig. 2 *β*, quite simple in its construction.

Fig. 1 *β* represents another star with spinose edges; there was also a crystal somewhat similar, in the form of a cuneate wheel, solid and opaque.

Fig. 2 *γ* was a leafy star, then came quite a different crystal from all the others, naked in its branches, but instead of being flat, it took the form of a ball.

Fig. 1 γ was the most remarkable crystal, in some respects not unlike the bloom of a marigold.

FIG: 2.

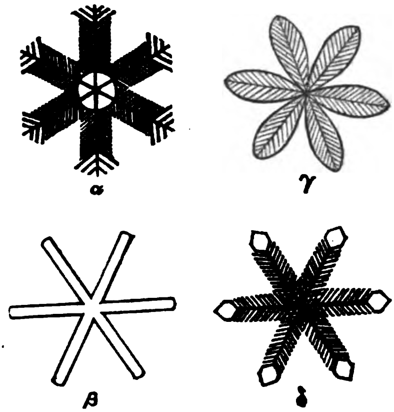


Fig. 2 δ was a feathery crystal, opaque, each branch hexagonal, and hollow.

At 11h. 50m. A.M., these crystals became mingled with very thin, transparent, and exceedingly small *needles of ice,* Fig. 3 a.

At noon, these needles fell briskly, and frequently two were united, mostly like Fig. 3 β.

At 12h. 5m. P.M., the needles had either assumed the form of feathers, Fig. 3 γ, or fell in bundles of feathers, Fig. 3 δ, and the crystals that now fell were much smaller, many of the size of Fig. 4 β, and some only just visible to the naked eye, like Fig. 4 γ. Before 11h. 50m. A.M., none were less than Fig. 4 a. The needles of ice when they first commenced falling were only equal in size to Fig. 4 δ, but soon became larger. The microscopic crystal, Fig. 4 γ, was just discernible as a minute circle, which, when magnified, resolved itself into a beautiful and complicated crystal.

FIG: 3.

In contrast to the microscope crystal, Fig. 4 γ, my brother (Capt. A. S. H. Lowe) sketched one at 11 A.M. on the 20th of February as large as a fourpenny-piece. This is represented, in Fig. 4 ϵ, of the natural size and form. I need not say this is a most unusual size, and more nearly approaches those described as seen in the polar regions by the arctic navigators.

FIG: 4.

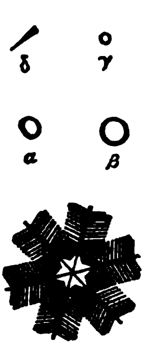


FIG: 5.

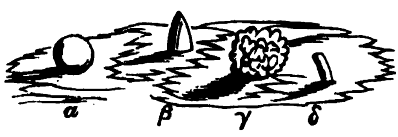
Returning to our present snow-storm, at 12h. 10m. P.M. the crystals were less in number, there

being now more needles, and feathers of ice in bundles, and amongst these were entangled one or more crystals, an example of which is represented in Fig. 5.

At 12h. 15m. small circular and conical opaque hailstones fell (Fig. 6 a and Fig. 6 β), which soon became very abundant, and were mingled with a few transparent bars of ice, Fig 6 δ.

At 12h. 35m. these hailstones were granulated, and had a double hexagonal form (Fig. 6 γ), which, when pressed with a hard pencil, broke into fragments, each fragment resembling the hailstone, Fig. 6 β, the pointed ends being in the centre of the hailstones, and the broad ends on the circumference. At 12h. 40m. P.M. the snow-storm ceased, after having given so great a diversity of form and size.

FIG: 6.



To Mr. Glaisher we are indebted for many figures of remarkable snow crystals, which he has published in the *Transactions of the British Meteorological Society*. To Sir John Herschel we are also indebted for the plate in the new edition of the *Encyclopædia Britannica*. Two plates of my own sketching may also be found in the *Magazine of Natural Philosophy*, and recently (January 3rd) I had the gratification of observing *hexagonal crystals of hail*, an account of which will be found in the *Transactions of the British Meteorological Society*.

Snow crystals always contain *six* similar branches or sides, as the water crystallizes in hexagonals. These branches are not exactly alike, differing from each other as leaves on the same tree, yet bearing so strong a resemblance to one another, that if it were possible to separate the branches from a number of crystals, and mix them together, it would very readily be ascertained (through a microscope) which branches belonged to each crystal.

The severe winter of 1855 was peculiarly rich in exquisite snow crystals, especially on the 22nd, 23rd, and 26th of January, on the 3rd, 6th, and 12th of February, and on the 11th and 22nd of March.

It is not uncommon to see two or more crystals frozen together; and occasionally a shower will come on, in which the crystals are broken up and mutilated, remnants of crystals being found amongst the snow-flakes.

The large woolly-like snow-flake which speedily covers the ground is not the kind of shower in which to see snow-crystals; these large flakes usually fall at a temperature scarcely below the freezing point; as the cold increases, the size of the snow-flakes decrease, and usually, if snow falls from 26° to 30°,

crystals will be observed: colder than this, the deposit will only be as icy spiculæ, or needles of ice.

Until the scientific balloon experiments, it was generally thought that the snow crawled along the ground, whilst the hail was formed at a considerable altitude. As a contradiction to this, Mr. Glaisher has passed through snow-storms a mile above the earth. In winter, whilst in mountainous districts, snow-storms may be seen travelling amongst the valleys, without ascending the mountains; and although the mountains are more frequently covered than the valleys, it usually happens, from this circumstance, that whilst rain falls in the valley, the colder hills are receiving it in the form of snow.

It may be that the snow in winter is very close to the ground, ascending higher into the air the warmer the weather becomes.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1864.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Jan. 1	29·996	33·1	21·7	·66	·137	34·9	32·9	2·0	9, 4, 5	NE by E, ENE, NE.	·149
„ 2	30·521	30·1	...	...	...	33·2	24·6	8·6	10, 10, 4	NNE, E, E by S.	·000
„ 3	...	...	...	...	...	32·6	23·2	9·4	...	... ...	·000
„ 4	30·527	27·9	20·7	·77	·132	31·3	21·5	9·8	3, 4, 2	NE, NE, NE.	·000
„ 5	30·314	28·4	22·3	·80	·140	31·8	25·6	6·2	10, 6, 8	NE, ENE, NE.	·000
„ 6	30·248	19·5	...	...	...	24·0	14·0	10·0	10, 9, 10	—, —, —.	·000
„ 7	30·202	20·8	19·2	·94	·125	28·2	12·2	16·0	9, 7, 10	—, SW, SW by S.	·000
„ 8	30·010	25·6	24·1	·95	·150	30·2	15·6	14·6	7, 10, 10	—, NE, NE.	·000
„ 9	29·924	34·6	33·6	·97	·211	39·5	18·4	21·1	10, 10, 10	E, NE by E, E by N.	·000
„ 10	...	...	...	...	...	45·1	31·5	13·6	...	... ...	·005
„ 11	30·120	40·0	35·2	·84	·223	47·1	33·2	13·9	6, 0, 0	SE, SE by E, SE by E.	·003
„ 12	30·115	39·7	37·0	·91	·238	41·7	35·6	6·1	7, 10, 10	SE, SE, E by S.	·000
„ 13	30·317	36·9	37·0	1·00	·238	38·1	36·9	1·2	10, 10, 10	NE by N, N, NE by N.	·136
„ 14	30·279	35·8	34·7	·96	·219	37·2	34·8	2·4	10, 10, 10	N, E, S by E.	·019
„ 15	30·292	32·9	32·0	·97	·199	34·6	29·2	5·4	10, 10, 10	E, E by N, E by N.	·000
„ 16	30·238	35·2	30·3	·84	·187	38·8	31·4	7·4	10, 9, 10	SE by E, SE by E, E by S.	·002
„ 17	...	...	...	...	...	40·9	32·0	8·9	...	... ...	·176
„ 18	30·114	41·7	41·8	1·00	·281	44·4	37·0	7·4	10, 10, 10	ENE, E by N, NE by N.	·008
„ 19	30·207	43·9	40·2	·88	·266	47·0	39·1	7·9	10, 7, 10	S, SSW, S.	·000
„ 20	30·237	44·5	43·1	·95	·294	47·7	41·5	6·3	10, 10, 10	S by W, S by W, S.	·185
„ 21	29·980	44·3	40·6	·88	·270	46·9	44·2	2·7	10, 7, 2	W, SW, SSW.	·044
„ 22	29·812	50·2	47·9	·93	·347	52·6	42·2	10·4	10, 10, 10	SSW, SW, SW by S.	·002
„ 23	29·842	47·6	41·7	·81	·280	50·2	49·3	0·9	10, 10, 10	SW, SW by W, SW by S.	·007
„ 24	...	...	...	...	...	45·4	34·0	11·4	...	... ...	·175
„ 25	30·435	40·4	39·6	·97	·260	43·4	30·9	12·5	10, 8, 10	SW by S, SSW, S.	·025
„ 26	30·231	40·6	34·7	·81	·219	43·9	37·6	6·3	0, 2, 1	SSW, SSW, SW by S.	·000
„ 27	30·004	48·3	44·2	·87	·305	51·5	36·3	15·2	10, 7, 10	SW by W, W by S, SW.	·017
„ 28	29·920	44·7	35·3	·72	·224	47·3	41·1	6·2	4, 10, 9	W by S, W, NW by W.	·000
„ 29	30·424	35·7	25·4	·69	·157	38·1	35·0	3·1	5, 6, 2	NE, E by N, NE by E.	·004
„ 30	30·470	34·6	29·4	·83	·181	38·5	22·0	16·5	10, 3, 2	SW, SSW, S by W.	·000
„ 31	...	...	...	...	...	41·3	25·6	15·7	...	... ...	
Monthly Means.	30·184	36·8	33·7	·81	·220	...	...	9·0	...	...	0·957

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—January, 1864.

Day.	Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
	12	27	13	2	8	8	5	1	2	3	7	5	7	3	6	4	11	16	4	6	16	25	25	30	4	7	3	15	19	18	1	1	9·6
A. M.	1	29	11	1	8	8	2	1	2	2	5	6	7	3	5	2	9	13	2	8	14	27	23	33	4	7	6	15	20	18	2	2	9·5
A. M.	2	28	15	2	9	7	2	1	2	7	6	6	8	4	5	1	15	15	0	7	12	22	20	33	3	6	5	15	19	17	1	1	9·5
A. M.	3	26	14	3	12	6	2	0	0	5	7	5	7	5	9	3	17	12	2	6	12	25	26	37	4	4	4	16	16	14	1	2	9·7
A. M.	4	31	12	2	13	12	2	0	1	6	6	7	11	3	6	9	17	14	2	5	13	26	27	36	4	4	5	16	20	13	1	2	10·5
A. M.	5	33	5	5	10	17	1	1	2	5	7	9	9	4	8	5	14	18	1	4	18	23	28	33	4	5	7	15	17	10	1	2	10·0
A. M.	6	30	8	9	8	18	1	1	1	5	10	5	8	3	5	7	15	15	5	2	12	21	27	31	3	5	7	18	18	13	2	8	10·4
A. M.	7	29	6	8	11	17	2	1	1	4	8	3	10	5	6	12	16	14	6	4	12	15	26	27	4	4	10	17	15	15	3	6	10·2
A. M.	8	26	6	6	9	14	1	1	0	5	6	5	10	6	1	8	14	9	5	6	12	12	29	21	5	3	11	11	12	15	6	6	9·1
A. M.	9	28	5	13	17	10	1	1	1	4	5	8	11	5	2	9	17	15	2	7	13	11	27	17	5	7	10	12	15	10	7	2	9·6
A. M.	10	34	11	14	16	9	1	4	1	4	5	9	8	6	3	6	15	...	2	11	15	11	29	15	10	8	15	14	19	13	10	5	10·7
A. M.	11	32	10	13	15	9	1	3	2	7	7	5	9	5	3	7	10	10	3	13	17	8	27	13	11	6	24	16	21	11	14	8	11·0
	12	24	11	16	19	12	2	2	2	6	8	9	6	6	7	7	14	10	3	13	15	10	34	11	13	6	7	18	23	13	16	12	11·5
P. M.	1	30	8	15	20	11	1	3	5	7	9	13	6	5	6	10	14	10	5	14	18	12	32	12	12	7	9	18	22	8	15	12	11·9
P. M.	2	30	9	13	23	15	1	4	4	6	6	11	4	6	6	11	17	8	2	16	15	10	29	7	13	6	13	17	23	13	15	10	11·7
P. M.	3	32	8	20	18	15	2	2	3	7	7	9	6	7	5	9	15	9	8	15	16	9	30	6	10	4	13	15	23	14	11	8	11·3
P. M.	4	30	7	21	16	7	2	3	4	8	8	9	4	7	3	10	12	7	2	13	19	9	30	9	6	2	11	17	21	8	10	5	10·3
P. M.	5	23	2	28	13	3	1	1	2	10	5	7	3	3	2	11	13	3	1	14	22	11	24	11	6	3	8	16	21	4	6	4	9·1
P. M.	6	20	3	17	18	7	0	2	3	13	7	9	3	5	2	11	13	2	3	16	22	13	28	11	6	2	8	14	20	5	3	5	9·4
P. M.	7	19	3	13	17	6	0	2	3	11	6	10	4	7	2	10	17	1	5	17	20	11	28	16	9	4	6	16	17	5	5	3	9·5
P. M.	8	16	3	12	14	5	1	1	2	10	5	7	3	6	2	6	10	2	3	18	21	12	26	15	10	5	3	18	12	5	5	4	8·4
P. M.	9	17	3	10	20	3	1	2	3	9	6	8	3	8	2	6	13	1	6	14	21	19	25	13	9	4	7	21	13	5	2	1	8·9
P. M.	10	18	4	7	21	4	0	2	4	9	9	7	3	6	2	8	16	1	5	16	25	23	14	6	11	3	10	18	15	4	4	1	8·9
P. M.	11	17	2	8	14	2	2	1	4	6	6	7	4	7	1	8	15	1	8	14	25	25	26	5	8	3	16	18	9	1	5	1	8·7
	12																																
Total Daily Movement.		629	179	258	349	225	34	40	54	159	161	179	154	125	99	180	339	201	80	259	400	390	640	448	174	115	218	386	430	247	146	111	9·9

Erratum.—In our February (1864) Number, p. 41, for Total Daily Movement on October 8 read 455 instead of 155.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1864.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Feb. 1	30·205	40·2	35·5	·85	·225	45·4	25·0	20·4	3, 6, 10	S, WSW, SW by S.	·000
„ 2	30·146	45·2	43·1	·93	·294	50·0	36·1	13·9	10, 10, 10	SSW, SW, SW by S.	·010
„ 3	30·021	45·8	39·4	·80	·259	49·0	45·2	3·8	10, 10, 3	WSW, W by S, W by S.	·013
„ 4	30·203	36·7	28·5	·75	·176	41·4	32·6	8·8	0, 5, 2	W, N by W, NW by N.	·010
„ 5	30·244	33·0	27·1	·81	·167	36·8	27·0	9·8	0, 10, 8	N, N by W, NW by N.	·020
„ 6	30·135	31·4	28·5	·90	·176	35·3	30·1	5·2	4, 8, 2	NNW, N by E, N.	·000
„ 7	...	...	...	...	...	31·0	24·0	7·0	...	... ...	·000
„ 8	29·731	31·5	28·3	·89	·174	35·5	25·1	10·4	10, 6, 10	N by W, N, N by W.	·000
„ 9	29·602	30·6	26·1	·85	·161	36·4	21·6	14·8	6, 5, 7	SW, WNW, NW by W.	·000
„ 10	29·443	30·9	26·3	·85	·162	38·1	17·9	20·2	9, 1, 10	—, NNW, N.	·000
„ 11	29·809	33·0	29·0	·87	·179	35·4	22·4	13·0	10, 10, 10	WNW, W, WSW.	·000
„ 12	29·427	46·5	45·4	·96	·319	52·1	32·0	20·1	10, 10, 10	S, SW by W, WSW.	·317
„ 13	29·760	50·0	43·7	·81	·300	54·3	41·6	12·7	10, 10, 1	SW, SW by W, W by S.	·032
„ 14	...	...	...	...	...	50·3	36·4	13·9	...	... ...	·002
„ 15	29·881	46·3	45·1	·96	·315	50·0	41·6	8·4	10, 10, 10	SW by S, SW by S, SW.	·000
„ 16	29·753	43·9	37·8	·81	·244	49·9	44·8	5·1	10, 9, 4	SW by W, WNW, W by S.	·019
„ 17	30·039	36·8	30·2	·79	·187	43·0	33·1	9·9	4, 10, 10	NW, NNW, N.	·081
„ 18	30·227	32·6	26·9	·82	·166	37·7	30·2	7·5	6, 8, 4	N, E by S, NE by E.	·028
„ 19	30·314	27·8	25·1	·90	·155	31·3	28·4	2·9	9, 7, 9	NE, NE, NE.	·000
„ 20	29·965	26·4	20·7	·81	·132	29·6	23·6	6·0	6, 10, 9	NE, NE, NE by E.	·013
„ 21	...	...	...	...	...	31·8	26·0	5·8	...	... ...	·000
„ 22	29·868	29·9	28·8	·96	·178	33·7	28·7	5·0	10, 10, 10	NNW, — —.	·000
„ 23	29·930	31·1	29·3	·94	·181	34·4	23·7	10·7	10, 10, 3	NE, NE, NE.	·000
„ 24	29·960	33·7	26·8	·78	·165	37·1	25·1	12·0	6, 10, 10	NE, ENE, NE by E.	·000
„ 25	29·967	34·6	29·4	·83	·181	37·7	30·8	6·9	10, 10, 10	ENE, E by N, ENE.	·124
„ 26	29·942	35·1	35·0	1·00	·222	37·3	33·4	3·9	10, 10, 10	N by E, —, ENE.	·004
„ 27	29·743	36·3	36·4	1·00	·233	38·7	34·5	4·2	10, 10, 10	E by N, E, E.	·000
„ 28	...	...	...	...	...	49·2	36·0	13·2	...	... ...	·036
„ 29	29·628	41·3	41·0	·99	·274	44·6	38·5	6·1	10, 10, 10	E, NE, WSW.	·020
Monthly Means.	29·918	36·4	32·7	·87	·209	...	...	9·7	...	... ...	0·729

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—February, 1864.

Day. / Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Hourly Means.
A.M. 12–1	1	18	28	11	7	14	9	5	3	1	9	11	10	10	14	15	8	7	21	11	12	6	1	4	15	13	9	12	19	10·5
1–2	8	17	29	10	15	12	7	8	4	0	7	11	11	9	11	14	6	4	20	11	14	5	2	6	16	12	9	10	6	10·0
2–3		17	26	11	14	15	7	8	2	1	5	11	6	10	10	14	6	3	20	11	14	7	1	6	18	12	9	11	8	10·1
3–4		19	25	9	11	15	12	8	3	1	6	17	20	6	13	13	12	4	20	12	16	4	1	10	16	11	9	14	9	11·3
4–5		16	25	7	7	17	10	8	4	1	8	20	21	8	13	15	10	3	20	13	15	0	2	10	14	11	9	15	8	11·0
5–6		17	18	7	7	16	5	9	4	1	6	19	24	8	17	13	8	5	23	9	13	1	3	7	12	13	9	15	6	10·5
6–7	26	20	14	8	8	18	4	9	4	3	4	24	28	9	14	12	10	8	23	11	7	1	2	9	14	11	9	10	8	10·8
7–8		17	15	8	12	20	9	8	3	1	8	24	32	10	11	11	9	8	23	10	15	1	4	11	16	11	9	11	6	11·5
8–9		18	13	8	12	16	5	9	4	1	8	26	35	11	13	13	13	8	21	13	15	1	5	14	15	12	11	8	4	11·9
9–10		17	15	10	13	15	10	8	5	1	8	25	30	14	12	13	13	8	24	16	12	2	4	13	14	8	14	7	5	12·0
10–11	14	18	13	13	20	15	9	9	6	2	7	27	30	20	18	12	20	10	26	20	11	5	5	16	15	10	15	10	6	13·9
11–12	16	20	16	11	20	19	10	9	4	3	6	22	37	20	18	13	20	10	21	15	11	5	3	15	17	10	19	10	6	14·0
P.M. 12–1	16	21	16	14	17	11	11	12	7	2	8		39	20	23	20	20	11	25	19	13	1	6	19	18	15	18	6	2	14·5
1–2	15	25	16	13	20	16	11	9	6	2	8		38	20	20	23	20	12	22	17	14	5	7	21	22	11	16	5	2	14·9
2–3	15	26	15	14	18	17	10	9	9	7	8	96	32	19	17	21	18	12	21	20	11	2	8	22	23	12	16	4	4	14·6
3–4	12	24	15	9	18	15	10	4	7	9	3		32	20	17	22	17	7	21	16	12	2	10	19	18	12	13	7	4	13·4
4–5	11	25	14	6	17	11	9	6	7	10	8		25	23	17	18	15	20	23	19	13	1	10	19	18	12	14	8	8	13·7
5–6	9	24	11	5	15	13	3	3	4	6	4	12	16	19	14	15	9	15	21	17	14	1	7	17	17	11	14	5	3	11·2
6–7	13	27	10	5	15	13	2	5	4	7	4	12	17	16	20	15	4	18	16	17	10	1	9	20	14	9	13	6	1	11·1
7–8	15	25	12	7	15	9	2	3	5	9	7	9	19	20	18	13	7	10	17	15	9	2	7	21	14	9	9	5	2	10·9
8–9	18	21	8	8	15	11	4	2	3	10	5	10	16	19	18	14	5	10	14	15	7	1	6	16	12	8	8	5	1	10·0
9–10	16	19	15	7	16	12	5	5	4	10	7	5	13	23	16	11	8	14	12	15	8	2	5	16	13	8	6	6	2	10·3
10–11	18	23	11	8	19	10	4	3	4	11	8	9	13	13	17	11	7	15	12	15	7	1	7	15	12	9	10	13	3	10·6
11–12	17	24	9	8	16	10	8	4	1	8	7	11	10	12	16	6	6	15	14	14	8	0	5	15	11	8	10	16	3	9·9
Total Daily Movement.	235	498	389	217	347	340	171	163	107	107	154	401	554	359	377	347	271	237	480	351	281	57	120	341	374	258	273	219	126	11·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1864.	Reduced to mean of day.					Temperature of Air.			At 9.30 A.M., 2.30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9.30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Mar. 1	29·823	42·2	40·3	·94	·267	49·2	29·6	19·6	10, 6, 8	SE by E, SSE, SSE.	·114
„ 2	29·788	36·3	36·8	1·00	·236	46·4	29·0	17·4	10, 10, 4	NE by N, S by E, N.	·010
„ 3	29·610	36·3	37·6	1·00	·243	40·8	32·7	8·1	10, 10, 10	ENE, ENE, ENE.	·000
„ 4	29·549	48·5	44·9	·88	·313	55·3	36·7	18·6	10, 7, 4	SW by S, SW, S.	·493
„ 5	29·367	40·8	41·9	1·00	·282	46·2	37·9	8·3	10, 10, 10	E by N, E by N, E by N.	·013
„ 6	...	...	...	...	...	52·8	39·5	13·3	...	... ...	·460
„ 7	29·041	45·0	39·0	·81	·255	50·6	40·6	10·0	10, 10, 9	SW by S, WSW, WSW.	·043
„ 8	29·139	38·5	37·4	·96	·241	45·1	41·9	3·2	10, 10, 10	N, NW, NE.	·165
„ 9	29·119	31·2	31·1	1·00	·193	34·7	33.9	0·8	10, 10, 10	N by W. N, N.	·240
„ 10	29·681	36·9	32·5	·86	·203	44·4	27·7	16·7	3, 5, 1	SW by S, SSW, SW.	·346
„ 11	29·555	44·6	37·0	·77	·238	50·9	35·3	15·6	7, 4, 2	SW, SW, WSW.	·065
„ 12	30·146	43·3	31·3	·66	·194	48·9	37·1	11·8	1, 5, 3	WSW, WNW, W.	·126
„ 13	...	...	...	...	...	51·3	35·3	16·0	...	... ...	·008
„ 14	30·031	47·8	40·9	·78	·273	54·7	43·1	11·6	10, 10, 7	WSW, W, W.	·000
„ 15	29·871	44·4	40·7	·88	·271	51·5	45·1	6·4	10, 10, 10	SW by W, WSW, N.	·020
„ 16	30·136	39·6	36·1	·88	·230	46·6	34·0	12·6	10, 2, 0	NE by N, E, E by S.	·050
„ 17	30·086	40·9	29·6	·67	·183	47·8	32·5	15·3	9, 8, 6	ESE, SE, E.	·000
„ 18	29·770	40·1	28·5	·66	·176	46·9	30·4	16·5	3, 3, 1	E, NE by E, E.	·000
„ 19	29·629	47·1	38·6	·75	·251	55·4	34·1	21·3	5, 2, 3	E, ENE, E.	·000
„ 20	...	...	...	...	...	56·9	31·9	25·0	...	... ...	·000
„ 21	29·647	41·0	37·0	·87	·238	49·4	35·5	13·9	10, 3, 4	NE, NE by E, E.	·000
„ 22	29·669	38·9	34·4	·85	·217	43·9	38·1	5·8	10, 10, 10	NE, NE, NE by N.	·000
„ 23	29·914	41·4	29·1	·65	·180	48·2	35·9	12·3	8, 6, 3	NE, NE, NE.	·005
„ 24	29·967	41·6	32·8	·73	·205	48·6	26·2	12·4	9, 7, 6	SSE, NW by N, ENE.	·000
„ 25	...	...	...	...	...	50·0	25·0	25·0	...	... ...	·000
„ 26	29·547	37·4	34·0	·88	·214	...	33·5	...	10, 10, 10	N, N, N by E.	·000
„ 27	...	...	...	...	...	45·7	30·8	14·9	...	... ...	·044
„ 28	29·285	42·8	33·3	·71	·209	46·8	35·4	11·4	7, 10, 9	NW by W, W, W by S.	·000
„ 29	29·352	38·9	31·2	·76	·194	47·1	34·0	13·1	10, 8, 1	NNW, N, WNW.	·162
„ 30	29·562	39·8	34·9	·84	·221	47·2	31·0	16·2	10, 9, 5	SW, NW, W by N.	·240
„ 31	20·751	44·7	41·1	·88	·274	50·9	31·0	19·9	6, 10, 9	SSW, SW, SW.	·034
Monthly Means.	29·655	41·2	35·8	·83	·231	...	...	13·8	...	... ...	2·640

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—MARCH, 1864.

Day. Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
A.M. 12–1	3	2	6	6	3	25	30	4	6	12	31	18	8	16	20	1	8	10	14	8	13	17	19	2	3	5	12	10	15	5	7	10·6
1–2	4	3	8	4	3	25	28	4	8	11	24	17	8	17	25	0	8	8	8	6	11	14	18	3	2	3	11	9	15	4	6	10·2
2–3	5	4	11	2	4	25	22	6	11	10	21	15	6	16	25	0	10	8	6	4	14	14	16	1	3	4	12	10	16	6	6	10·1
3–4	6	5	12	2	8	23	19	7	9	8	20	12	7	22	25	1	11	6	8	4	16	17	19	1	2	4	13	7	16	6	6	10·4
4–5	8	5	13	9	8	17	21	11	9	9	22	12	5	21	26	3	13	8	7	5	17	14	21	1	2	8	12	10	19	5	8	11·3
5–6	7	4	13	4	6	14	20	9	12	8	22	17	8	21	24	7	13	6	8	7	15	15	17	1	3	6	8	9	20	2	6	10·7
6–7	8	5	17	2	14	15	18	5	9	7	24	14	8	17	19	5	12	8	7	6	20	13	20	2	3	4	10	9	21	5	5	10·7
7–8	9	9	18	4	12	12	17	7	13	8	26	15	8	18	20	4	11	8	11	6	20	10	21	1	4	9	15	12	23	2	5	11·6
8–9	9	6	17	7	14	8	25	7	14	8	29	18	11	21	25	2	14	14	11	8	19	15	23	1	2	10	18	16	25	1	7	13·0
9–10	5	9	20	2	19	4	30	5	11	13	28	15	17	16	21	7	15	16	15	10	25	14	20	3	3	11	22	20	24	3	18	14·0
10–11	10	8		5	17	10	25	5	12	17	30	19	23	18	20	14	13	21	20	15	23	16	20	4	1	13	22	22	24	5	20	15·7
11–12	10	8		10	16	21	28	12	11	21	25	29	23	23	21	14	16	22	16	23	17	17	22	3	4	14	20	19	27	5	20	17·2
P.M. 12–1	9	4		14	15	24	32	12	12	28	35	20	23	21	19	26	27	21	15	25	24	18	22	3	3	14	18	21	28	8	21	18·7
1–2	9	2	114	11	15	30	29	11	15	27	27	18	20	23	18	17	27	23	19	28	21	19	22	2	4	14	17	24	17	12	28	18·1
2–3	10	2		10	16	30	28	10	19	21	26	19	22	18	19	16	19	25	22	27	19	20	22	4	5	17	17	27	23	16	22	18·4
3–4	10	6		8	18	30	22	5	21	19	28	18	23	18	16	17	18	23	20	27	20	17	22	3	4	13	13	24	22	10	19	17·1
4–5	9	10		7	21	30	15	9	24	15	29	13	22	17	11	19	23	22	21	26	19	19	20	7	1	14	11	23	15	14	26	17·1
5–6	6	10	18	9	25	21	16	9	20	12	22	11	20	14	10	15	23	24	17	21	20	18	14	9	1	15	8	25	14	13	27	15·6
6–7	5	6	11	6	25	22	12	15	20	17	27	10	20	11	5	10	17	23	18	21	19	17	12	7	1	18	4	26	10	13	26	14·6
7–8	5	9	12	6	25	18	10	12	15	18	26	10	20	16	3	10	12	17	21	17	25	17	10	5	2	19	3	14	7	13	26	13·6
8–9	3	8	13	3	25	23	6	10	17	19	27	8	19	19	2	8	13	15	14	20	24	18	13	1	1	18	5	20	6	14	24	13·4
9–10	2	7	15	2	29	29	3	5	16	24	23	8	15	21	1	7	10	12	11	20	19	16	10	2	2	14	7	22	5	11	24	12·6
10–11	3	10	14	4	26	27	3	8	12	26	18	9	18	22	4	11	10	11	6	20	20	21	9	2	3	11	7	21	5	10	27	12·8
11–12	2	10	8	3	25	30	5	8	13	27	14	9	15	20	2	10	9	15	5	14	21	20	4	2	4	14	8	17	4	7	18	11·7
Total Daily Movement.	157	152	335	140	389	513	464	196	329	385	606	349	369	446	381	224	352	366	320	368	461	396	416	70	68	272	293	417	401	190	392	13·7

STAR-FOLLOWING WITH TABLE STANDS.

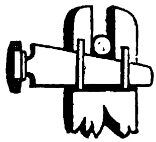
BY REV. E. L. BERTHON, M.A.

THE November number of the INTELLECTUAL OBSERVER contained a description of a new stand for astronomical telescopes likely to be acceptable to amateurs. The inventor wishes now to publish the sequel to that arrangement, showing a simple way by which the heavenly bodies may be conveniently followed, either, 1st, by a single movement of the one hand, or, 2nd, by a means entirely automatic. By referring to No. xxii. page 283, it will be observed that the movement in altitude is effected by a long screw turned by a little winch; and that in azimuth by a horizontal movement of the whole stand upon rollers.

It will be remembered that a slab of smooth slate, which may be had for three or four shillings, was recommended as the flat surface on which this stand should work. The slab should be about thirty inches long and eighteen inches wide, and instead of being fixed it should be made to revolve where required about a pivot. To accomplish the improved working of this stand, two pieces of wood cut this shape are fixed, one at each end of the slab, by means of a wedge. On the side of one of these pieces—that on the right hand—is placed a little sheave of brass working on a pin. Over this passes a piece of fine whipcord having a weight of three or four pounds upon it, and the other end made fast to the piece of wood on the other end of the slab. The cord is thus stretched across the slab in a state of tension.

We must now recur to the stand. The annexed woodcut represents, in real size, a section of the hinder part of the board or base: *a* is part of the long screw inclining upwards. This screw is prolonged backwards, and between its two bearings *b* and *c* it has a well-turned cone of boxwood, and terminates in a square end to receive the winch or handle *d*. The bearings *b* and *c* are prolonged upwards and support another spindle now to be described: it is made square between the bearings, and upon it is a flat wheel or disc of brass having its edge milled like that of a shilling, which is made to slide up and down the square spindle so as to touch the wooden cone at any desired part. On the same spindle behind the aftermost bearing is a brass sheave with several grooves of different diameters, *e*. There is also one more little sheave *f* working on a pin, round which and also round one of the grooves of the sheave *e*, is passed an elastic band to maintain a constant pressure between the cone and disc. Finally the

hinder bearing, *c*, is open like the letter u, so as to allow the spindle and disc to be raised clear of the cone; it is furnished with a little wedge which, when pushed in, lifts it up thus:—



Now to use this stand, the disc being kept free from touching the cone by means of the little wedge which is pushed in, the cord is passed completely round one of the grooves of the sheave *e* (either over or under according to the motion of the star to be observed). The stand is moved right or left by hand, and the altitude attained by the long screw. As soon as the star is found the little wedge is drawn back, and the disc is now pressed by the force of the elastic band against the cone, aided also by the weight at the end of the cord, and by the friction thus produced, the disc and cone now move together; thus the two movements in azimuth and altitude are simultaneously produced by turning the winch *d;* and their relative velocities are adjusted by sliding the disc to a larger or smaller part of the cone as required. Since there are several grades to the sheave *e*, and each may be acted upon by any part of the cone, a great variety of relative speeds may be obtained to suit the rising, southing, or setting of the heavenly bodies.

The above arrangement is found so simple and easy to work with, that any further degree of independence of manual action is unnecessary for the amateur astronomer on his own account, for with one gentle movement of one hand he can follow a star in any direction; but there are cases in which a complete automatic movement is desirable, as, for instance, in showing the planets to a number of young people one after another. The telescope once set may be kept with the object in the field for a quarter or half an hour by a very inexpensive mover, although hitherto such a luxury has been confined to the possessors of costly equatorial mountings, with equally expensive clockwork to keep them moving.

The prime mover to accomplish it is a plain *moderator lamp*, such as may be bought, without stand, globe, or chimney, for ten shillings. The wick-tube with the *smaller* rack and pinion is removed, and on the top of the little oil-pipe is soldered a very small gas-jet with stopcock, through which the oil may escape faster or slower as desired. The lamp filled with pure fine colza oil is attached to the slab of slate on the left-hand side and about a foot below it. Another pair of sheaves are now fitted, one to each of the blocks of wood on the slab; another piece of whipcord is used; one end of it is tied to the rack of the lamp which rises two or three inches when the lamp is wound up; it then passes over the two sheaves across the slab, and hangs down on the right side with another weight attached.

Now to employ this combination. Let the star be found as before, and the velocities in azimuth and altitude relatively adjusted; the cord from the moderator mover is now taken between the finger and thumb and passed round a small pin on the afterpart of the board or base of the stand, or it may pass under a little plate of brass and be nipped by a screw.

The lamp now takes charge of the whole affair, and slowly and steadily moves the stand towards the left, thus following the horizontal motion of the star or planet; but as the other *fixed* cord is passed round the sheave *e*, this movement cannot take place without turning it, and thus the vertical motion is obtained at the same time. The flow of oil is regulated by the stopcock; and if a greater force is required than that of the spring in the cylinder of the lamp, a weight of any amount can be placed on the top of the rack.

N.B. When the star to be observed is on or near the meridian no movement in altitude is required, so the little wedge is pushed in, and the disc revolving free from the cone, the winch may be transferred to the square above of the upper spindle.

SOLAR OBSERVATION.—TRANSITS OF JUPITER'S SATELLITES.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

THE most magnificent object of all human contemplation is, beyond a doubt, the great star to whose influence our planetary system has been subordinated by its Creator. Other suns, there is reason to believe, may be superior to it in magnitude, or at least intrinsic splendour, but in a remoteness which even the velocity of light, that reaches us in about eight minutes from the sun, can only measure by intervals of whole years, their individual features are, and ever must remain, unknown to us. As it was recently remarked in a very interesting paper, with which our readers are familiar, "We never see the Stars." On the other hand, the distance of our own sun is such as to place him within reach of even our smaller instruments, and to bring that enormous flood of light clearly before the spectator's eye;* while the magnitude, the variety, and the strangeness of

* A power of 180 represents the solar disc under so great an angle that its entire breadth, if it were comprised in one field, would fill up the whole sky from the horizon to the zenith. This may appear at first sight almost incredible, but it is matter of easy proof. The sun's diameter averaging a little more than half a degree, 180 suns, or one sun magnified that number of times, would occupy a space of upwards of 90°. This may serve to show how fallacious may be the judgment of our sight in the absence of any known object of comparison.

his phænomena, are such as to invite our most attentive inquiry. To this inquiry peculiar importance has been given of late years by the discovery of an apparent connection between the physical changes in the sun's surface and the electrical condition of the earth, as shown by magnetic variation; and a field has thus been opened for the most remarkable investigations. Such researches require, indeed, a great amount of perseverance. It was not till after twelve years of incessant attention that the celebrated German observer, Schwabe, succeeded in convincing himself of the existence of that periodicity in the development of spots which seems to stand in such mysterious balance with the electrical state of the earth, and, therefore, in all probability, with the conditions of vegetable and animal existence. His investigations were subsequently continued through nineteen subsequent years, and in all, for thirty years, as the President of the Astronomical Society said, in presenting to him their gold medal, never did the sun exhibit his disc above the horizon of Dessau without being confronted by Schwabe's imperturbable telescope, and that appears to have happened about three hundred days in a year. Nor was that other important discovery of the currents by which the spots are so frequently caused to drift from their places achieved by our own observer, Carrington, without a great expenditure of time and patience. On the other hand, the student who is disposed to explore this region of mysteries may remember, for his comfort, that his inquiries will be greatly favoured by the number of available hours during which the object is in sight, as contrasted with the short time allowed for nocturnal observations without encroaching on the natural season of rest, and by the additional chances thus given of intervals of clear sky, as well as by the frequent occurrence of very distinct vision through an amount of haze which would, in the case of less luminous bodies, be an absolute prohibition. This branch, too, of astronomical study bears a favourable comparison with some others of the highest interest—for instance, the determination of the periods of binary stars—in the inexpensiveness of the necessary apparatus, and the facility of observation, while a great stimulus to its prosecution may be derived from the opinion of so great an authority as Carrington. Four years of patient investigation have led him to the conclusion that "our knowledge of the sun's action is but fragmentary, and that the publication of speculations on the nature of his spots would be a very precarious venture." And, in referring to the designs of Schmidt, he says, "he believes that no observer will examine these delineations without finding many characteristic features not satisfactorily explained by any existing theory of the origin and formation of the spots, and without a conviction of the neces-

sity of accumulating other equally excellent series for the future establishment of correct views of this mysterious phænomenon." Amateurs, again, who have not the opportunity, or the inclination to take up the inquiry in a regular and consecutive manner, may yet find it most interesting as an occasional pursuit. Nothing, assuredly, is more grand than the telescopic aspect of that huge incandescent globe; nothing more marvellous than the dark gulfs which interrupt the continuity of its blaze; nothing more surprising than their rapid and almost incessant transformation. These are wonders, indeed, with regard to which, as in the instance of comets, the absence of analogy leads us almost to despair of any adequate explanation; yet this does not detract from the curiosity always attendant upon such gigantic displays of ever-active energy; and at the present time the subject receives an addition of interest from the discussion which has been carried on among some of our first observers, as to the exact form and distribution of certain peculiarities in the luminous surface. For many reasons, therefore, the subject is one with which amateurs may be desirous of becoming practically acquainted.

The study is, however, not to be entered upon without due caution. There is no other branch of astronomy in which any evil result is to be apprehended for a sight of ordinary strength; but the sun cannot, of course, be contemplated directly through the telescope without the risk of destruction to the eye; and even a degree of protection which might be deemed adequate by an inexperienced beginner may prove insufficient to prevent bad consequences. It has been stated that want of caution in this respect was the origin of Galileo's blindness, and that Sir W. Herschel injured one eye from the same cause. We cannot therefore begin our remarks more appropriately than by giving our readers some hints which may enable them to regard this ocean of flame with safety and comfort.

Few persons have such an eagle eye as to be able to fix their sight straight upon the noon-day sun; but there is no reason to think that those who can do so are sufferers from it, though even in this case a lengthened gaze might not be desirable. But matters are very different as it regards telescopic vision. In this, there is not only a great concentration of intensity, a large proportion of the rays collected by the object-glass being poured into the pupil of the eye; but an enlargement of angle, by which the mere luminous point representing the sun upon the unaided retina is expanded into a broad glaring disc. The impression of excessive light alone must be expected to be prejudicial to an organ not originally adapted for such excitement; but that of concentrated heat is probably still more

injurious. The object-glass of a telescope is, in fact, a burning-glass, and though its comparatively long focus, from the enlargement of the image, disqualifies it from producing the most powerful heating effect in proportion to its area, yet its energy in this way is not to be trifled with. A remarkable instance is given by Secchi of the activity of a $9\frac{6}{10}$ inch object-glass in the pure sky of Rome. Without any further concentration of the cone of rays than was due to the field lens of an eye-piece, a piece of the whitest paper exploded in the focus instantaneously like gunpowder, and 3 *grammes* (= 46·3 grains) of lead were melted in less than two seconds. Various schemes have been devised at different times to obviate the danger from this source. The most natural one, that of contracting the aperture of the telescope to very small dimensions, is not so successful as might perhaps have been expected, since, for reasons which involve a knowledge of mathematical optics, the focal image becomes less defined in proportion to the acuteness of the angle at which the intersection of the rays takes place. Herschel I., therefore, in older times, and Dawes in these, not to mention other observers, have pronounced in favour of using the largest available aperture; and the latter has remarked that the solar phænomena, "when carefully scrutinized with large apertures and high powers under suitable atmospheric circumstances, are so wonderfully different in their appearance from those presented by the diminished apertures formerly and necessarily in use, that it would not be very surprising if some observers, unaware of what had previously been seen and described, should imagine that the phænomena revealed by their newly acquired and powerful telescopes were really new discoveries." The excessive and perilous light and its attendant heat must therefore be all admitted first, and neutralized afterwards, as best we can. This could not be well done by interposing any screen of dark-coloured glass in front of the object-glass, since it would be difficult to find a sufficiently homogeneous piece of the required diameter, or to work it to plane and parallel surfaces with due correctness.* It has commonly been introduced behind the eye-piece, and close to the eye, in which position its very small dimensions exempt it from the disadvantages which have been mentioned; but even there it is not pleasant in use, as preventing the eye from coming near enough to command the whole

* I have somewhere met with a suggestion, but do not now recollect where, as to the construction of a solar telescope by employing as an object-glass a single lens of deep-coloured glass; this, transmitting only rays of nearly the same refrangibility, would be sufficiently achromatic, but the uncompensated spherical aberration would render rather a long focus desirable. The idea is ingenious, and might be worth a trial.

of the field. To avoid this, the late Mr. Lawson, of Bath, who was the possessor of a very fine 7-inch achromatic by Dollond, presented by him, at the close of his life, to the Greenwich Naval School, introduced the screen between the object-glass and the focus, very near the latter, in which position, however, it frequently was cracked by the heat. This is, indeed, an accident to which these glasses are often liable. The most experienced of solar observers, Schwabe, speaks of it, though in his case the screen was probably placed, as usual, in the exterior brass cap; and he remarked that the occurrence took place most commonly in years, such as 1833 and 1843, when few spots were visible. In some measure this might certainly be due to the lower temperature of the spots themselves—a curious fact, which has been fully established by Secchi; but should their relative area be considered too small to produce such a result, it would tend at any rate to show that, contrary to the opinion of Sir W. Herschel, their development was concurrent with diminished energy in the calorific influence of the sun.

As we have to deal with heat as well as light, it is by no means immaterial by what means the darkening process is effected. It is generally known that the rays of heat are distinct from those of light, and being less refrangible than the latter, are co-incident for the most part with the red end of the spectrum, extending even considerably beyond its ordinary limits. Glass, therefore, which freely transmits rays of that colour, being equally permeable by the rays of heat, is peculiarly ill adapted for a screen; its frequent employment in the solar caps of the older telescopes may probably have been owing to the superior readiness with which it could be procured, of sufficient depth, transparency, and uniformity of tint; but its effect was distressing to the eye. Green would be far preferable, as intercepting the heat, but it is difficult to obtain it of a tinge sufficiently powerful to subdue the excessive light. Deep yellow has also been used, but nothing seems preferable to a dark bluish-grey, or neutral tint, which gives a beautiful and comparatively cool image. Combinations of colour have been found very effective. Since white light is composed of what artists call the three primary colours—red, yellow, and blue, and the two latter form green, it is obvious that a combination of red and green, provided the tints were carefully balanced in quality and intensity, would transmit white light, with very little heat, the calorific rays being intercepted by the green glass; and such screens are said to be very pleasant. Sir J. Herschel speaks highly of cobalt blue (the colour of finger-glasses) interposed between two thicknesses of green,

and purple and green have been used by others.* From the great convenience of being able to vary its intensity at pleasure, a thin wedge of coloured glass has been recommended, prevented from acting as a prism by a similar wedge of plain glass placed in contact with it the reverse way. A plain glass wedge between two tinted ones of red and green, each of half the angle of the colourless one, was used by the Astronomer Royal for the eclipse in 1851. Such combinations must, of course, be made to slide easily across the eye-hole, or be held in the hand during observation. To attain the object of variable intensity, the ancient plan of smoking a piece of glass succeeds as well as far more expensive contrivances; it is also said to intercept heat much more completely than its hue might have led us to expect; probably in consequence of the absorptive power of the carbon; a slip may be nicely graduated as to depth by a little care in smoking, but will require to be protected from accident by another piece of clear glass placed over it, and kept from touching it by interposed bits of paper. In the preference of tint, however, another consideration must be taken into account, which ought to influence our choice in delicate observations. There is reason to believe that some of the minuter solar details possess a decided colour, which would be acted upon more in proportion than white light, by a screen of such a hue as to neutralize their own. Delicate veils of a ruddy cast, for example, such as have been noticed by Secchi, might be rendered imperceptible by the non-transmission of their light through green glass, or even a combination into which it entered; while the general clearness of the rest of the image would give no intimation that such a defalcation had taken place; and instances are on record where the remarkable phænomena of a great solar eclipse have been considerably modified from this cause. It would therefore be advisable, when minute features are to be carefully scrutinized, to be prepared with glasses of various tints.

A strong reason for caution, however, when ordinary screen-glasses are employed, exists in the fact that different telescopes seem to have different foci for heat. Mr. Reade, in one instance, found the burning effect much the strongest a little way short of the solar focus, so that the calorific rays diverged, while those of light emerged parallel from the eye-piece; and hence he recommended an eye-hole, like that of a Gregorian reflector, between the eye-lens and the screen-glass, to intercept the heat; by which means he found that an aperture of six inches could be used with safety. On the other hand, a

* It is a curious fact that this mode of observation with two differently stained glasses was anticipated, before the invention of the telescope, by Fabricius, in the solar eclipse of 1590.

case has been given of one eye-piece alone, out of a set, producing such a focus of vehement heat just at the front of the screen-glass, as partially to fuse its surface in two minutes with only three inches of aperture. A closer position is said to have saved the glass; and we must *hope,* without injury to the eye.

Other methods of subduing the heat have been adopted with success. The elder Herschel made use of a filtered mixture of ink and water, enclosed between parallel pieces of glass. The late Mr. Cooper, of Markree Castle, Ireland, found that a glass "drum" containing alum-water was so effectual that he could employ his whole aperture of 13·3 inches,* using merely dark spectacles to subdue the glare; while, on the other hand, during the great eclipse of 1851, Lassell found that the free heat of only 2·55 inches, with a focus of 32·5 inches, broke the dark glasses "with most alarming rapidity." To avoid risk of this kind, he used the wise precaution of previously exposing them to artificial heat. An ingenious helioscope, in part suggested by Sir J. Herschel, but improved and actually constructed by Colonel Porro, in Paris, deserves especial mention. It is a modification of the Newtonian telescope, in which metallic specula are replaced by those of unsilvered glass. The large concave mirror of course transmits all but a very small proportion of the incident light; the second reflection takes place at the surface of a small plane mirror, or "flat," as it is technically called, which stands at the angle of complete polarization of light; while a third reflection is produced from another similar mirror connected with the eye-piece; or the latter may be furnished with a "Nicol prism;" by the rotation of either of which arrangements round the axis of the cone of rays, the light, already reduced to a very minute fraction,† may, as those who are acquainted with the mysteries of polarization will readily perceive, be further diminished to any required degree, and the employment of coloured glasses rendered needless, even with considerable apertures. This beautiful device has also the merit of great comparative cheapness, but the disadvantage of being nearly useless for other than solar observations, and we have no sufficient information as to its accuracy of definition.

* This great instrument, twenty-five feet in focal length, was, as far as I know, the largest specimen of the workmanship of the French optician, Cauchoix. Its purchase by the late possessor was the unintentional means of increasing the dimensions of the great achromatic at Poulkowa, as the Czar Nicholas, on learning its magnitude, was determined not to be outdone in a private observatory, and altered his original order for one upon a larger scale. It was employed at Markree chiefly in the formation of an extensive catalogue of stars, and was recently offered for sale in consequence of the proprietor's death.

† This and similar values are so differently stated in different places, even by high authorities, that I have not specified them. The question of the amount of light reflected at various angles of incidence seems still open to inquiry.

We shall postpone to another opportunity our remarks upon other expedients of still greater practical value.

TRANSITS OF JUPITER'S SATELLITES.

As the opposition of Jupiter takes place on the 12th, the shadows of the satellites will be seen during the month in close proximity to the bodies which cast them, varying, however, of course, in this respect, from perspective, in proportion to the distance of the satellite from its primary, and changing sides at the time of opposition. The transits at convenient hours will be the following:—May 1st. Shadow of I. passes off the disc at 11h. 8m., followed by the satellite at 11h. 24m. 4th. Shadow of III. enters at 9h. 31m., III. itself at 10h. 32m.; their departures being at 11h. 40m. and 12h. 15m. respectively. 5th. Shadow of II. goes off at 10h. 35m.; the satellite at 10h. 54m. 8th. Shadow of I. enters at 10h. 50m.; I. at 10h. 57m.; the departures being at 13h. 2m. and 13h. 7m. 12th. II. enters at 10h. 53m., 3s. after its shadow, and leaves at 13h. 9m., 2s. before it. If the planet were precisely in opposition, and also in its node (or passage across the ecliptic), at the time of a transit, the shadow would of course be invisible, being concealed by the body of the satellite. This curious coincidence can but seldom occur, but there will be an approximation to it on the present occasion, as the planet will be in opposition with less than 57′ of N. latitude.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*March* 23.

New Fossils from the Lingula Flags.—Mr. J. W. Salter described two new genera of Trilobites, and a new genus of sponge recently discovered by Mr. Hicks in the hitherto scanty fauna of the Primordial zone. He also remarked that the fauna of the Lingula flags shows an approximation, in some of its genera, to Lower Silurian forms, and some—the Shells and a Cystidean—are of genera common to both formations; but the Crustacea, which are the surest indices of the age of Palæozoic rocks, are entirely of distinct genera; and their evidence quite outweighs that of the other fossils. The Primordial zone is, moreover, in Britain separated from the Caradoc and Llandeilo beds by the whole of the Tremadoc group, which are, at least, 2000 feet thick.

April 13.

The Siliceous Springs in the Nevada Territory.—Mr. W. P. Blake communicated a description of the physical features of this

elevated semi-desert region, which is composed of a series of longitudinal mountain ranges with alternating valleys and plains. The most abundant rocks are those belonging to the Igneous and Metamorphic groups; but Carboniferous limestone and Tertiary strata are also found.

The siliceous hot springs extend for some considerable distance along a line of fissure in a granitic rock, parallel to the mountain ranges. The water of these springs deposits silica in an amorphous and also in a granular form, sulphur also being deposited in the interstices of the siliceous deposit. These phenomena are interesting as illustrating the mode in which quartz veins are produced in fissures in other rocks, from the older strata to the more recent formations.

Mr. Blake also described the mineral veins of the district there occurring in porphyry. They yield metallic sulphurets, including those of silver, lead, copper, and iron, with a little native silver and gold, the veinstone being a friable quartz. The general direction of these veins is north and south, and the amount of gold yielded by them is more abundant near the surface than at greater depths.

THE RED ROCK AT HUNSTANTON.—Mr. Harry Seeley read a paper on the geological characters of this rock, in which its physical structure was first considered, and it was shown to be divisible into three beds, the uppermost of which is of a much lighter colour than the rest, the middle being concretionary in structure, and the lower sandy. These beds, with the overlying white sponge-bed, were considered to belong to one formation, and were termed the Hunstanton Rock; but the thin band of red chalk some distance above was considered, though of similar colour, to be quite distinct,* as also was the Carstone below. The author considered the lower part of the Carstone to be of the age of the Shanklin Sands; and as the Chalk is not unconformable to the Hunstanton Rock, he concluded that the latter could not be the Gault, but must be the Upper Greensand, —a conclusion which he afterwards showed was supported by the evidence of the fossils, and the occurrence of phosphate of lime.

The seam of soapy clay which separates the Hunstanton Rock from the chalk was supposed to have resulted from the disintegration of a portion of the former, the red colour of which the author endeavoured to show was due to Glauconite.

The upper part of the red rock of Speeton was thought to be possibly newer than that of Hunstanton, and perhaps to represent the time which elapsed between the formation of the latter and that of the band of red chalk.

LINNEAN SOCIETY.—*March* 27.

ON THE PHENOMENA OF VARIATION AS ILLUSTRATED BY THE MALAYAN PAPILIONIDÆ.—Mr. Wallace read a paper on this subject, in which he stated that the study of the Papilionidæ of the Malayan Archipelago was likely to illustrate the disputed subject of variation.

* An analysis of this remarkable mineral will be found in the INTELLECTUAL OBSERVER, vol. iii., p. 300.

Mr. Wallace considered that variation was by no means the simple fact that it has generally been regarded, but that it included the several phenomena of simple variability, of the existence of the same species in two or more forms, viz., Dimorphism or Polymorphism. Also, what may be termed local forms, and the consideration of sub-species and true species.

Simple variability, in which the offspring irregularly and, as it were, accidently differ from their parents, is of the same nature as that so characteristic of domestic animals,

Polymorphism or dimorphism differs from simple variability in the fact that the variations are more or less constant or regular. Thus, in the *Papilio Memnon* the males are always uniform both in form and colour, being bluish black. Some of the females resemble the males in shape, but are ashy-brown in colour. Others have wings with spoon-shaped tails, and marked with white. Either of these females will produce males and females of both forms, but it is remarkable that intermediate forms between these two varieties of females never occur.

Similar instances of polymorphism among the females occurs in the *Papilio pammon* and *P. ormenus.*

These phenomena of polymorphism may be illustrated by supposing an island inhabited by white men, with black, red, and yellow women, and that, even after many generations, the males born were all white, and the females indifferently red, yellow, and black, irrespective of the colours of their female parents. In many cases the difference between the polymorphic forms of the same animal is so great that they have been described as belonging to distinct species.

The influence of local causes, such as the presence or absence of particular enemies, tends to produce that remarkable variation known by the term Mimetic Analogy. For example, the butterflies of a group known as the Danaidæ have a peculiar scent, which renders them obnoxious to birds of prey, hence they are free from persecution.

If, in the course of the accidental variations to which all animals are subject, a Papilio resemble a Danais, even slightly, in form and colour, it will escape persecution more than if it had remained unchanged; and each succeeding generation, those Papilios most like the Danaidæ will be the most protected and the most likely to increase in numbers. This process will, therefore, gradually but certainly produce a constantly increasing likeness or mimetic analogy, until at last one insect can hardly be distinguished from the other except by a close examination of the structural peculiarities.

SOCIETY OF ARTS.—*April* 13.

New Method of Preserving Meat.—Dr. J. Morgan read a paper on a new method of preserving meat. According to this mode, the animals to be killed have an opening made in the chest, through which the heart is reached. Incisions are then made into the arterial and venous sides of this organ, and a stream of water, the force of which is obtained by its flowing from an elevated cis-

tern, is allowed to pass into the arteries, thence through the capillaries, into the veins, and to escape by means of the orifice in the venous side of the heart; in this manner the entire blood is washed out of the body, after which a solution of salt and sugar is injected as a preservative liquid. Similar plans were the subjects of patents taken out more than twenty years since, and were not found to succeed in practice. The theoretical objections appear to be, firstly, that by washing the blood out of the capillaries, the nutritive power of the meat is very much lessened; and secondly, that the preservative effect of the plan proposed is very doubtful. The antiseptic effect of salt is in great part owing to its power of abstracting water; this is not possessed by brine. It was stated that the meat preserved by Dr. Morgan's process was, when packed in barrels for ship use, headed on with a great amount of dry salt; this would have the same effect as the salt used in the ordinary plan of salting, and would slowly abstract the juice of the flesh, and render the meat as dry and innutritious as the ordinary plan.

ROYAL INSTITUTION.—*April* 15.

Recent Discoveries respecting the Properties of Gun-cotton.—Professor Abel delivered a most interesting lecture on the preparation and properties of gun-cotton; the lecture included a description of those recently discovered modifications, dependent on mechanical aggregation, which have enabled gun-cotton to be introduced with success in warfare, and for blasting purposes.

After detailing the objections to gun-cotton as ordinarily manufactured, objections which have hitherto precluded its use in actual service, Prof. Abel explained the action of nitric acid on cotton. He showed that it has two distinct modes of operation. If the nitric acid be permitted to act at a high temperature, and in an energetic manner, the carbon and hydrogen of the cotton may be completely oxidized. When, however, the action is moderate, and the temperature kept low, the hydrogen only is assailed, and is removed in gradations, peroxide of nitrogen being substituted for it. When two atoms of hydrogen are removed, and two equivalents of peroxide of nitrogen substituted, xyloidine is produced. When three atoms of each are interchanged, trinitro-cellulose, or pure gun-cotton is the result—100 parts of cotton losing 1·85 of hydrogen, and receiving 85·12 of peroxide of nitrogen. Intermediate stages may also be brought about, as in the preparation of that variety of gun-cotton used in the formation of collodion.

The original directions of the discoverer, Schonbein, order the nitric acid employed to be mixed with strong sulphuric acid, but from want of the requisite precautions in the manufacture, the product was uncertain in properties, sometimes even exploding spontaneously. By the precautionary measures adopted in the Austrian army, these uncertainties have been obviated.

The cotton loosely spun into yarn is boiled in a weak solution of alkali, in order to remove more easily oxidized materials, whose presence interferes with the action of the nitric acid. After this washing

the cotton yarn is dried in a centrifugal drying machine, and immersed in a mixture of one part of nitric acid (specific gravity 1·5), and three parts of sulphuric acid. Contrary to the original directions of Schonbein, it is allowed to remain immersed for forty-eight hours, so as to secure uniformity of result. During this action great care is taken to prevent the temperature rising. The cotton is then washed in a stream of water for a period of time varying from one to three weeks, and is subsequently dried in the open air; during this stage of the manufacture, some experiments have been tried as to the effect of steeping it in a solution of soluble silica prepared by dialysis, apparently with satisfactory results.

The properties of gun-cotton as prepared by the Austrian process appear to be very uniform and certain. When loosely arranged it inflames at a temperature of about 300° Fahrenheit, burning without smoke, and without leaving any ash. Its rapidity of ignition is so great that it does not ignite gunpowder when laid on its surface and exploded. By pressing a thin edge, as that of a stout card, on the centre of a tuft, one portion may be ignited without the flame communicating to the other. When gun-cotton is twisted into a yarn, its rapidity of combustion is perceptibly diminished; by varying the degree and tightness of the twist, the exact rate of burning required for different purposes can be secured, from the explosive violence necessary to propel balls from cannon to the slow combustion desirable in a mining fuse. An explosive gun-cotton resolves itself into gases, which are themselves combustible in air, consequently when a flask of gun-cotton is burnt in an open glass vessel, a secondary flame is seen, caused by their combustion.

Although the combustion of gun-cotton does not depend on atmospheric oxygen, its mode of burning is remarkably affected by the character of the gases in which it is burnt; thus in carbonic acid it burns with a feeble flame; in hydrogen, with one still feebler; in a receiver exhausted to a vacuum of 3 inches, it burns with a very slow combustion without light. The conditions requisite to the rapid burning of gun-cotton are, that the gases produced by the combustion should communicate sufficient heat to the adjacent portions to carry on the combustion. Hence, in gases like hydrogen and coal-gas, whose conducting power is very great, the heat produced is carried away so rapidly that the cotton almost refuses to burn.

By heating a twisted yarn of gun-cotton gently, a very slow combustion may be produced, or the same effect may be caused by blowing a current of air on a yarn in rapid combustion. The ease with which different rates of these combustions may be alternated was very strikingly demonstrated by Prof. Abel, who, after producing the slow rate of burning in a horizontal yarn, caused the combustion to become instantaneous by raising it to the perpendicular position, with the inflamed part dependent. Also, after having produced rapid combustion in one end of a long yarn, he changed it into the slow combustion by blowing the flame away from the unconsumed cotton, and back again to the rapid burning by blowing the current in the opposite direction.

NOTES AND MEMORANDA.

SCULPTURE OF THE REINDEER PERIOD IN CENTRAL FRANCE.—Messrs. Lartet and Christy have laid before the French Academy an account of their discoveries in the grotto of Eyzies, in the Arrondissement of Sarlat (part of ancient Perigord). They found bones, cinders, wrought flints, and implements of reindeer horn. They likewise came upon numerous fragments of a hard schistose rock, and on two slabs of the same material were profile engravings giving partial representations of animals. They believe these to be the first examples that have been obtained of this kind of art as practised by the men who were contemporary with the reindeer in France, and other temperate regions of Europe. At Langerie Basse they discovered another manufactory of arms and implements of reindeer horn, some of them ornamented with "elegant sculpture, and of workmanship quite astonishing, when the means of execution possessed by a people who had no metal tools is taken into consideration. At Eyzies they likewise found a bone whistle similar to one from Aurignac. Some of the bone implements from Langerie Basse were not merely engraved, but sculptured in relief. One represented a horse's head, and in another instance the handle of a weapon was carved into the representation of an entire animal. M. Vibrage adds divers reasons for believing in the antiquity of the human race; and after speaking of the weapon handle just mentioned, states that these early sculptors likewise reproduced the human form in the shape of an indecent idol, the materials for which seem to have been taken from the elephant."

COMPANION OF PROCYON.—Mr. Bird, whose success in constructing silvered glass telescopes has been described in a former number, states, in the *Astronomical Register*, that he has succeeded with his 12-inch instrument in resolving one little star in the same low-power field with Procyon into two stars 9.5 and 9.8 magnitude. Mr. Knott has also seen them with his fine refractor, and estimates their angle of position at about 200°.

COMMON ORIGIN OF COMETS IV. AND V. 1863.—M. B. Valz communicates to the French Academy his observations on these two comets. He shows that "their inclinations differ only 4°, and their nodes only 7°. The angle comprised between the planes of their orbits is 9°, and they arrive at the point of approximation of their orbits with equal velocities, and five days' interval. He remarks that in 1846 the comet of 6¾ years was seen to separate slowly in two parts, and their inclinations, orbits, nodes, and velocities experienced little alteration. In like manner he thinks comets iv. and v., 1863, may have had a common origin.

FAIRBAIRN ON IRON GIRDERS.—The *Proceedings of the Royal Society*, No. 61, contains a paper by Mr. Fairbairn on iron girders, in which numerous experiments are adduced. The conclusions arrived at are that "wrought iron girders of ordinary construction are not safe when submitted to violent disturbances equivalent to one-third of the weight that would break them. They, however, exhibit wonderful tenacity when subjected to the same treatment with one-fourth the load; and assuming, therefore, that an iron girder bridge will bear with this load 12,000,000 changes, it is clear that it would require 328 years, at the rate of 100 changes a day, before its security was affected. It would, however, be dangerous to risk a load of one-third the breaking weight upon bridges of this description, as, according to an experiment cited, the beam broke with 313,000; or a period of eight years, at the same rate as before, would be sufficient to break it." Mr. Fairbairn considers, however, that the beam had been injured by 3,000,000 previous changes, producing a gradual deterioration.

VARIATIONS IN DIFFLUGIAN RHIZOPODS.—Dr. Wallich has an elaborate paper in the *Annals of Natural History*, illustrated by very numerous drawings, showing varieties of structure in the tests of these creatures. His conclusion is that the "animal does not vary, but it modifies the architecture of its habitation, and the mineral material of which that habitation is in a great measure constructed, in obedience to local conditions, and in the manner best fitted to meet its requirements." A "species" of difflugia will, therefore, only be a variety,

capable of repetition under the very circumstances that determined the peculiarity of its habitation.

THE WILLOW LEAVES, OR RICE GRAINS, ON THE SUN.—In that useful journal of intercommunication between astronomers, the *Astronomical Register* for March, is a letter from Mr. Nasmyth, containing his original paper on the willow leaf-shaped objects on the sun, the existence of which, except as rarities, has been doubted by some other able observers. Mr. Nasmyth says a telescope of very considerable power and defining capacity is necessary. Mr. Dawes has seen the mottled aspect of the solar surface with a 2½-inch glass, and a power of 60. He finds, with a 6 or 8-inch telescope, and high powers, that the surface is chiefly composed of luminous masses of all shapes, imperfectly separated by rows of darker spots. Anything like Mr. Nasmyth's willow leaves he finds very rare, and only found in the vicinity of large spots in their penumbra. Mr. Nasmyth, in the letter alluded to, says they are scattered over the surface, and lie in all imaginable directions. He says he considers the penumbra to be a true secondary stratum of the luminous envelope revealed by the partial removal of the outer and luminous envelope. When a solar spot is mending up, he sees the willow leaves bridging it across. Mr. Dawes sees the spots under such circumstances bridged over by luminous masses like stray straws from a plat. Since the subject was discussed at the Astronomical Society some weeks ago, the objects in question have been seen at Greenwich with the great equatorial and a smaller instrument, the result being the confirmation of Mr. Nasmyth's statement, with a slight modification. The mottled appearance of the sun is now affirmed to be produced by a multitude of bodies like *rice grains*, rather than willow leaves.

NEW ANÆSTHETICS.—Dr. Georges has addressed a note to the French Academy detailing various experiments. He states that purified keresolene, obtained from petroleum oil, is a good anæsthetic, but requires the aid of heat. Brom-hydric ether he especially recommends as safer than choloroform, not easily inflamed, and having an exquisite odour.

HEARING OF CRUSTACEA.—M. Hensen has a paper on the auditory organ of the Decopods in the *Zeit. fur wiss. Zoologie*, xiii., 1863, an account of which will be found in the *Archives des Sciences*, No. 74. To show that these creatures are quick of hearing, he placed prawns, or shrimps, in a vessel of sea water, containing strychnine, which augments the reflex power of nervous centres. A slight noise then caused the animals to bound away. He states that different sounds cause different hairs, which are connected with the auditory cavity, to vibrate. A particular note will make one hair vibrate, while its neighbours remain quiet.

PRODUCTION OF OZONE BY AGITATION OF AIR.—M. C. Sainspierre informs the French Academy that he has ascertained that ozone is developed by the mechanical action of blowing machines and ventilators producing strong currents. This fact may in part account for the healthy action of winds, and should be viewed in connection with Mr. E. J. Lowe's paper in our last number.

OBTAINING PALATES OF MOLLUSCA.—Mr. T. W. Wonfor obligingly sends the following:—"If you have not heard from any other source of a simpler method of obtaining the palates of mollusca than that mentioned in the Rev. E. Rowe's paper, I would call your attention to a plan suggested by Mr. Hennah. I have tried it, and found it very simple and successful. It is to boil the head of the mollusk in liquor potassæ in a test tube, by which means all parts, with the exception of the palate, are destroyed. The palate may now be taken out, washed in distilled water, and mounted. Those who have tried the dissection of minute mollusca will find this a saving of time and patience. It is better to boil the potassæ in a hot-water bath."

SEEING VENUS AS A CRESCENT.—The recorded instances of this planet having been seen as a crescent with the naked eye are very few, and the following extract from Theodore Parker's journal adds an interesting case to the brief list:—"When twelve years old I once saw the crescent form of Venus with my naked eye. It amazed me. Nobody else could see it; father was not at home. Nobody knew that the planets exhibit this form. So I hunted after a book on astronomy, and

got it from the schoolmaster, and found out the fact and its reason." This was at Lexington, U.S. It is probable that if persons with keen sight would watch their opportunities in exceptionally still and clear states of the air, the crescent of Venus might be more frequently seen. The minuteness of the object may not be so great a difficulty as the ordinary tendency of the atmosphere to blur definition.

THE 80TH PLANET.—This little object has been named Sappho by its discoverer, Mr. Pogson, of the Madras Observatory.

A STRANGE SURGICAL ACCIDENT.—*Cosmos* quotes from *l'Union Médicale* a strange story of an accident, resulting in the death of a woman sixty-three years of age, who was under M. Guèrin, at the Hôpital St. Louis. The patient suffered from luxation of the shoulder of three months' duration. She was placed under chloroform, and force steadily applied by four assistants, who worked some machinery (*les lacs contra-extenseur, and extenseur*), the precise nature of which is not explained. All of a sudden a dull sound was heard, and the poor woman's arm snapped off at the elbow. On examination it was found that the bones, muscles, and tissues possessed very little cohesion.

FLINT IMPLEMENTS FROM SYRIA.—The Duc de Luynes, accompanied by M. Louis Lartet, has obtained numerous flint implements, accompanied by the bones of herbivorous animals, from the caverns on the river Lycus, in Syria.

FECUNDITY IN CUBA.—M. Ramon de la Sagra communicates to the French Academy illustrations of the enormous families resulting from marriages in Cuba. In Trinidad, with a population of 14,463, ten couples had 13 children, one couple 24, two 21, one 18, one 16, and two 15. In St. Espiritu, with 12,850 population, fifteen marriages resulted in offspring to the extent of from 13 to 26 children, while in Villa-Clara, with 10,511 population, twelve happy pairs had produced 147 young ones. Many Cuban children become mothers at thirteen, and reappear in that character up to the age of fifty. M. de la Sagra compliments the Cuban ladies upon their extreme amiability, and fitness for all the duties of maternity; but, we fear, inquiry would show that there is very little intelligence among them, and that they lead the lives of well-fed, contented animals.

LARVAL REPRODUCTION IN INSECTS.—*Siebold and Kölliker's Zeitschrift*, for 1863, relates a curious discovery by Professor N. Wagner of some worm-like insect larvæ filled with smaller larvæ of the same kind. Except in the remarkable fact that the mothers are themselves only *larvæ*, these instances resemble the asexual reproduction of the aphides. The larvæ were obtained from under the bark of elms in Kasan, and appear to belong to some species of diptera. The *Archives des Sciences* remarks, "That amongst the asexual plant-lice the *pseudova*, or false eggs, are found in an organ which is the homologue of the ovary in the sexual individuals; whilst in the apodal larvæ observed by M. Wagner the pseudova are formed in the fatty body. This organ divides itself into a certain number of lobes, which surround each one with a special membrane."

OZONE AND ANTOZONE.—The *Archives des Sciences* for March contains an interesting account of the views of Clausius on oxygen. He considers that ordinary oxygen consists in atoms united two and two, and active oxygen in single, or disunited atoms. The two atoms which constitute a molecule of ordinary oxygen he regards in opposite electric states. Referring to M. Soret's opinions, M. Clausius observes that they coincide with his own, as his reasoning is not affected by the supposition that ozone is formed of elementary atoms not united in pairs, which may combine with molecules of non-decomposed oxygen as soon as they become free.

A. T. Flwes Del.

Cases of the Caddis Worm.

THE INTELLECTUAL OBSERVER.

JUNE, 1864.

THE CADDIS-WORM AND ITS HOUSES.

BY ELIZABETH MARY SMEE.

(*With a Coloured Plate.*)

Amongst the vast world of animal life which abounds in such profusion in the rivers and ponds of Great Britain, there are few creatures perhaps which will be found more interesting for observation than those insects which dwell at the bottom of the water whilst they exist in the imperfect or larva state. There are some of them which are doubly curious from their inhabiting houses of their own construction, and in which they may be seen walking about at the bottom of ponds or rivers.

At first sight it might seem highly improbable that larvas of any sort of insect should have the faculty of building houses wherein to dwell, but nevertheless it is perfectly true that there are some which have that power given to them, and so well is it employed, that often very beautiful houses are the results of their labour.

The larvæ which form the subject of this memoir, belong to insects of the same order as the dragon flies, namely, the Neuroptera,* and to the family Phryganeidæ. They are more commonly known as caddis-worms.

The bodies of these so-called caddis-worms are, with the exception of their head, very soft; in fact, exactly resembling ordinary meal-worms. They are possessed of six feet, whose uses, as will be presently seen, are employed in more ways than that of merely conveying them from one locality to another. They have also very strong jaws or mandibles, and short antennæ, or feelers. At the end of the last segment or telum is situated two little hooks, which are curved or sharply pointed. These little hooks are strong, and are the chief weapons the larvas employ in guarding their houses for their own use, for by them they are enabled to fasten them-

* In Westwood's *Introduction* they are placed under the order Trichoptera.—Ed.

selves in their houses, and thus resist the attacks of any enemy who may endeavour to pull them forcibly out of their abodes.

These cases or houses, which the caddis so tenaciously guards, are made of different materials, depending upon the locality in which it lives, and also the kind of substances it is able to procure. For instance, if the caddis inhabits still waters, such as ponds where water plants abound, or gently running streams, it will often use the leaves of those plants, and with them most ingeniously make for itself most comfortable and beautiful houses. The leaves are in this case arranged in such a manner that it would seem that not only comfort but also beauty of structure is considered. It is quite a curious sight to see these creatures walking about at the bottom of the water encased in these green portable houses, to which are usually attached a piece of stick or a stone to prevent the caddises and their dwellings from rising to the surface. Sometimes half a dozen may be seen at one time, and in each there is a slight difference of construction, according to the taste and convenience of the worms. It should be perhaps here added, that after the house is completed the head and legs of the larva are the only part which is visible, the rest of the body being always kept encased in its domicile. But these green houses are not the only kinds which are found in still waters. Other kinds may be seen which are made of very small stones, almost as fine as sand, and there are others again which are made up entirely of sticks, their length and size varying much.

In rapid streams, as cases made from leaves of water plants, and stones, so small as those just mentioned, would be speedily swept away by the current, we find that they are built of more solid and heavier kinds of materials. In such streams, if made of stones, the caddis cases are much larger and heavier.

One of the most curious of all the different kinds of houses or cases are those which are entirely made of shells of creatures inhabiting the same stream as the caddis-worms. These cases are frequently found to be constructed of shells of the Planorbis, a small snail, arranged in a most grotesque manner. Frequently the creatures are alive in these shells employed by the caddis in making its house, and then when it walks about it carries the shelled animal, very much to the discomfort of the latter.

Such are the most frequent kind of caddis cases which are found in the rivers and ponds of Great Britain. But it by no means follows that the caddises are incapable of making them from other kinds of materials than those found in the water

where they live. Indeed, they are able to employ various substances, although their capabilities for building are limited to a certain extent in regard to the material and its form. This was found by myself, from experiments tried with the creatures themselves. Having felt extremely interested in watching these caddises walking about with their differently constructed houses at the bottom of the water, I felt an intense desire to find out everything about them.

It was noticed that when the caddis was turned out of its case and placed in a small vessel of water containing the materials with which it was wished to form another, the larva would construct for itself a new house from those materials, provided they were within the limits of its capabilities.

As soon as the caddis-worms find themselves denuded of their houses, they commence forthwith with the materials that may be given to them, and build new ones, never stopping until the greater part of their bodies are encased.

Coloured glass, when broken up into small pieces, makes an extremely pretty case. The colours may be either sorted or mixed, for in either way the case is extremely pretty. With broken pieces of glass the caddis builds very rapidly. In fact, I generally found that cases made from that material were constructed more quickly than when the worm was supplied with other substances. Why this was so I do not know; however, glass is particularly adapted for the caddis to build with. If a case of a better sort of material than glass be desired, it will be found that amethyst or cairngorm will answer the purpose well. But although the caddises are able to construct from either of these sorts of stones, yet I used to observe that when given to them the houses were always much slower in their construction.

Cornelian, agates, and onyx are all capable of being adapted for cases, and look exceedingly well when finished, especially if used separately. A coral house makes a very grand-looking abode for a caddis, but as it is heavy, care should be taken that the pieces be selected from the most slender and thinnest part of a sprig of coral. Pieces of marble broken up into tiny fragments can be successfully employed by the caddis. Shells, mother-of-pearl, when broken into small pieces, or small shells entire, are very quickly made into suitable dwellings by caddises.

I have had cases made from brass shavings, and also from gold and silver leaf. With the two last-named materials the worms experienced considerable difficulty, for they are unable to take up portions separately of gold and silver leaf, and they are obliged to roll themselves up in it in an irregular way.

Another material capable of being made into a caddis case is coralline. This substance forms a very curious dwelling. I had some constructed from pieces of a kind of coralline when dead, or rather when only the skeleton remained of it. These pieces of this dead or skeleton coralline are blanched, and are put together in such a manner that the case has an appearance as if it had been the work of a basket maker, instead of that of a larva.

But perhaps a more singular-looking case than even these wicker-work ones are those which are made from pieces of tortoiseshell, such as fragments of the teeth of a tortoiseshell comb. If these be given to a worm, it will be seen that it will arrange them crossways. In doing so it will make its house slightly resemble a hedgehog whose bristles are erected. It seems astonishing that there is such a variety of form in the appearances of these different caddis cases. For what can be more unlike each other than cases made from fragments of the teeth of a comb, and that from the pieces of skeleton coralline? What also is more extraordinary, is, that the same worm which can build the basket-looking case can also construct the one resembling a hedgehog when its bristles are erected. In fact, if a caddis is able to make itself a case from any one of the substances already mentioned, it is able to build from all of them. For I have tried their capabilities in that way by giving a caddis a certain kind of material to construct its house, and as soon as it was completed I turned it out, and then give the same worm something different to work upon.

With these new materials it would commence building with as much ease as it did with the former materials, although consisting of a totally different kind of substance from that which it employed in the formation of its previous case.

Although these caddises are so wonderful in being capable of forming cases for themselves of such a variety of structure, yet it is not every substance that they are able to employ for building materials. They are incapable of using anything when existing in a certain form. For instance, although glass is an easy kind of material for a caddis to work with, yet if the form and surface of that glass be smooth and round, as in a small bead, the caddis will be totally unable to make a case from it. In broken glass the pieces are always somewhat angular, and present no difficulty to the worm. Generally, I may state that not only round beads, but every object which is rounded in form and smooth in surface, is unfit for building material, whilst substances with angles and curves are quite fit for the use of a caddis-worm. There are some substances that exhale certain odours, which render them also quite unfit to be used. These scented materials are so highly noxious to the

worms, that they often completely stupefy the creatures, and sometimes even cause their death. If pieces of pine wood be placed in a vessel, and if a caddis be kept amongst that wood, in a short time it becomes stupefied, and would ultimately die if suffered to remain. This stupefaction is caused by the turpentine which is contained in such large quantities in all kinds of pine wood.

Slate is another substance which caddis-worms are unable to employ for their building. I attribute this to a similar cause as that which prevents caddis from using pine wood, namely, the odour. In these cases, however, the substance does not cause any injury to the worms. The same obstacles arise with both coal and brick.

Although there are many kind of metals that can be employed by caddis-worms, yet there are some from which they are quite unable to construct their houses, such, for instance, as lead and copper. I have myself repeatedly endeavoured to get a caddis to use these metals just named, but it was always in vain; although worms would try again and again to build from them, they invariably failed.

It will always be found that if any caddis is not able to construct itself a house from any kind of substance which might be given to it, no other caddis could form a house from the same material. Any number of caddises may be tried for that purpose, yet the results are always the same.

It has before been stated that the weight of caddis cases depends upon the locality that is inhabited by the worms, for it is found that the more rapid the streams, the heavier are the cases.

When a caddis is turned out of its house, the whole surface of its body is covered with air-bubbles. Now, if these creatures are placed under these circumstances in running water, they speedily rise to the surface and float, until at last they die from exhaustion in their struggles to regain the bottom of the water.

This being then the use of the cases to the caddises, let us now see the manner in which they construct them. It is, indeed, an interesting sight to watch them during the progress of their building. The worms commence by placing together a number of pieces of the substances they wish to employ. These are then cemented loosely together, so as to make a foundation for building its subsequent structure. These first pieces that are used as a foundation are always cast off before the completion of the edifice. The cement used by the caddis in fastening the pieces of its house together, is a secretion which proceeds from its mouth. With it the different pieces are fixed together in the most perfect manner. This cement

answers the same purpose to the caddis-worm as the mortar which is used by the bricklayer in the construction of his buildings. After the foundation has been formed, the caddis proceeds by lifting up with its feet a piece of the material it is employing for its building. This is turned on every side, either in order to discover whether the piece will or will not suit, or else to find out which is the side that will best fit into the space required for it. If the piece is found to answer all the purposes required by the caddis, it is cemented into the space reserved for it by this secretion, which as I have stated before, proceeds from its mouth. If, however, the piece does not suit the space, that piece is instantly rejected, and another one is taken up by the worm in the same manner as the previous one was. Sometimes the caddis is obliged to take up several pieces before it is able to meet with one fit for the purpose. This makes the task of building extremely tedious and laborious. Indeed, with the creature's slender legs it seems marvellous that it is able to take up the different pieces with them, particularly when heavy ones are selected, which is the case when the worms inhabit rough waters. For in those localities the materials are principally large stones, or else thick heavy bits of wood, which must render the building extremely laborious. The building is continued by the caddis in the manner just described without stopping, until it has succeeded in rearing a house according to its taste. When it is completely finished, the whole body of the worm is encased in it, with the exception only of its head and legs, and these even are capable of being drawn into its building, either for its pleasure or for their protection at the appearance of danger.

The caddises are exceedingly fond of the houses which they take so much pains to build, and it is often very troublesome to deprive them of their habitations. They fasten themselves into the end of their houses by the means of those two little hooks which have already been alluded to, and by the aid of which they are enabled to bid defiance to any enemy who might try to denude them of their abodes. When the caddis is once hooked into its case it will often suffer itself to be torn into two rather than allow itself to be dragged out. The obstinate resistance on the part of these caddis-worms often offers some difficulty when it is wished that they should build another case.

But it will be found that caddises will creep out of their cases, if slightly irritated by gently pushing a pin into the end of their case. By this method both case and worm will escape damage and injury.

Now caddises are able to make more than one case for themselves when former ones are destroyed. When I tried

some experiments with them, I found that five was about the greatest number I ever obtained from one caddis. The last one was not nearly so strongly or firmly cemented together as the first one. After the fifth one was made, the caddis, when turned out of it, would invariably bury itself under the heap of the materials given to it without even trying to make another case. It seems that the secretion used for cementing the parts together was entirely used up and failed to be further produced. But although five was found to be the greatest number obtained from one caddis, yet it should be stated that if the worms were captured as soon as they were hatched, and experiments tried with them, I believe they would be able to make more than that number. Frequently they did not succeed in making so many as five cases.

I have seen the small caddises, just hatched, building their tiny houses as early as the beginning of January; of course being then very little creatures, the materials they are only able to employ must be of the smallest description, like sand, etc., for with larger or heavier materials they would not have the strength to take the particles up with their then tiny feet. As they grow so they must enlarge their houses, always building until the creatures cease to grow larger; but in what way they expand the circumference of their dwelling I have not been able at present to observe.

The time taken for a caddis to construct a case varies very much. With some substances a caddis takes more than double the amount of time and labour that it does with others, for with some materials they finish their work in about twenty-four hours, with others again it takes more than a week to do it. It has been already stated, that cases made from broken pieces of glass, jet, shells, or marble, were very much quicker in their construction than when the worms were supplied with either amethyst, or cairngorm, or coral. A shorter time is always taken in the early part of the season, for as the period approaches for the larvas to turn into the pupa state, they require a much longer time to build.

If it be wished to keep caddis-worms for the purpose of watching these creatures constructing their cases, it will be found to be advisable to let each worm have a separate place to work in. They are so extremely quarrelsome towards each other, that if you denude several worms of their houses, and place them together in a vessel of water containing materials for them, you will find that instead of beginning to build they will commence a most deadly warfare with each other, their animosity never being appeased until some one stronger than the rest succeeds in killing them off. After this the survivor will commence his house as if nothing had

happened. The best way is to let each caddis have a small jar of river water for itself, and which should contain the substance it is wished its house should be built of. The water should be changed daily, so as to let the caddis have always a fresh supply of oxygen, and also to keep the materials bright and clean which it employs.

When the period arrives for these larvas to become pupas they gradually lose their activity, until at last they withdraw their head and legs entirely into their cases, and remain in a completely dormant state for a short time until their last transformation, when they burst open their cases, and rise to the surface of the water in their new and glorious forms of perfect flies. They dry their wings and skim along the surface of the water, their instinct leading them to perform their new career as if they had been accustomed to that state of existence all their lives.

The period in which the transformation from larvas into flies takes place does not always fall at the same time at different parts of the country. In the south of England it generally occurs about the middle of May.

The colour of the fly is brown. It is possessed of four wings, which are equally long, and very much resemble network. Whilst at rest the wings are placed longitudinally. It has also long antennæ. The flies always keep near the water. Their great enemies in all states of their existence are trout, with other fish, who devour them freely; the trout even eat cases and all of the caddis; although they greatly prefer them without the stones and sticks which cover the bodies, as then they consider them exceedingly dainty morsels, and in that condition they are thus found a killing bait by the angler.

But caddis-worms are equally as rapacious as the trout themselves. They have really a tremendous appetite, taking into consideration their size. I have observed that if this was not satisfied they were never sufficiently nourished to be able to undergo their final transformation, but would die whilst existing in the pupa state. When I kept these creatures I used to feed them on pieces of uncooked meat, which they would eagerly seize from my fingers, and ravenously devour. It used to surprise me to see how much such small animals could manage to get through at a meal. They will also eat a common house-fly, the wings, legs, and head being alone rejected as unfit. But meat, if that be cooked, no caddis will offer to touch, however hungry he may be. It is only whilst the caddises are in the larva state that they are so carnivorous. When living in the streams their food consists of the numerous creatures that exist there, as insects, polyps, mollusks, and

they have even the reputation of eating the ova of trout. But after taking into consideration the leathery case and the roundness and smoothness of the ova, and the difficulties which they must present to the caddises, I am inclined to doubt the assertion that they cause in any way their injury. I have placed the ova of trout in the same vessel with caddises, but never knew one to be eaten, and even have known a caddis to incorporate ova into its case. But with the other-named creatures I myself have been an eye-witness of their rapacity. Indeed, as far as the mollusks are concerned, caddis-worms seem to consider them an extremely delicate food, judging from the amount of them they consume when they can get the opportunity to do so. I will here give a little anecdote to prove this, and also to show in what manner I discovered their rapacity in that way.

I had some fresh-water mussels, belonging to the family *Mytilaceæ*, and called the *Dreissena polymorpha*. They were given to me rather as curiosities, and which I kept in an aquarium, containing, amongst other things, caddis-worms. After a short time I found to my mortification a great number of my mussels were dead, as I at first thought, although I was surprised that I never found any trace of the dead creatures, their shells being always open and clean. This state of things went on for a few days, my shells, or rather their inhabitants, vanishing in a most mysterious and unaccountable manner; until one day I saw a caddis walk deliberately up to one of the mussels, whose respiratory orifices were protruded from the partly open shell of the mussel, which was enjoying itself in the nice bright water of my aquarium, not dreaming that there was any danger so near to it.

Well, as soon as the caddis had reached close to the mussel, it seized hold of the siphoned orifices, which are the respiratory orifices of the mussel, and then devoured the poor creature up. Beginning with the part that it first attacked, and continuing its havoc until the shell, or rather the two shells (for mussels are possessed of two shells), were completely emptied. Other caddises were also discovered demolishing others of the same kind of mussel, after a similar manner as that just described.

The mussels which are mentioned here are natives of northern and eastern parts of Europe. They were first discovered in England in 1824, in the Commercial Docks, and have been supposed to have been brought to England amongst some timber. They have been carried to the River Lea, and increased plentifully in the reservoirs and even in the water-pipes of the New River Company in the Green Lanes. By their fertility they have become almost a nuisance, and I may confidently suggest to the New River Company the importation

of caddis-worms into their reservoirs as a means for their extermination.

Now after all that has been stated on the variety of structures of caddis cases, it should be borne in mind that however great may seemingly appear to be the difference between the different cases, such as between the wicker-work house of the caddis and that which was made from the teeth of a tortoise-shell comb, yet the general design of those houses is identically the same. For instance, if they be compared together it will be seen that all the cases are made of the same shape, namely, in that of a tube, and that the same smooth surface is found to exist in the interior of those houses. The only difference between them consists in the manner in which the pieces of the material are arranged, and not in the design of the whole. The design upon which the case is made is derived from instinct, which is implanted into the organization of the creature by nature, which leads them to construct cases of such a uniformity of plan as was said in an analogous case by Gilbert White, in his *Natural History of Selborne,* that "The God of Nature is their secret guide." As soon as the creature is hatched it commences building a house without experience and without knowledge, and without even requiring to be taught, and which is as perfect in its structure as if it had the most extended experience and the most correct knowledge, and the same plan will also be observed in all instances. Instinct then does not proceed from the operations of the mind, but is something which is implanted into the nature of the creatures as a part of their organization, and which causes them to act upon that idea that has been implanted. With respect, however, to the choice of each stone, the caddis is guided by a particular adaptation of each piece for its purpose, and to that extent acts as well as man could do under similar circumstances. Whilst the design of the case is clearly instinctive, as much reason is shown in the choice of materials as man could exercise under the same conditions.

In these pages I have endeavoured to point out simply the principal features of that wonderful instinct which is possessed by the larvæ of that order of insects commonly known as caddis-worms. The facts which I have mentioned were all ascertained by trying experiments with them. For, as I have said at the commencement of this paper, the experiments were carried on solely from an intense desire to know what were the capabilities of these curious creatures. But I feel convinced that more can be learnt of them, and it is in the hope that others may be incited to the same object that this account has been written, which contains that which I myself have learnt through my own observations made upon

creatures obtained from the streams in our garden at Wallington. That it was attended with great amusement I need hardly add. Should any one wish to discover more about them, let them try experiments themselves with these creatures. In the month of April they will find in the rivers the caddis-worms in a most active state, each busily employed in building their differently-formed cases.

Description of Plate.—Fig. 1. Case of a caddis, found in the river where the current is slow. It is built of small stones, attached to a long strip of wood, which balances the weight of the stones. Fig. 2. Case of a caddis found in rough waters. This is much heavier than the former. Fig. 3. Case of a caddis when the larva was turned out of its former one, and was supplied with the teeth of a tortoiseshell comb. Fig. 4. Case as taken out of the river where the stream is moderate. It is formed of the shells of planorbises and shells. Fig. 5. Case made of jet. It should be added the same larva made five cases from this same material. Fig. 6. Case made of the filings of brass. Fig. 7. Case made of sprigs of red and white coral, and will be seen to be a heavy one. Fig. 8. Case made from broken pieces of different-coloured glass. Fig. 9. Case as existing in the river, it consists of small stones and strips of wood, one of which is much longer than the other. Fig. 10. Case of caddis made of silver leaf. Fig. 11. Case of caddis when the larva was supplied with pieces of coralline. It will be seen that the pieces are put together in such a manner that the case bears a great resemblance to basket-work. Fig. 12. Case made when a caddis was supplied with pieces of amethyst. Fig. 13. Caddis case constructed of pieces of cairngorm. Fig. 14. Case made of willow shavings. Fig. 15. Case of a caddis from a gently running stream; it consists of small stones attached to two long sticks. Fig. 16. Case made when the caddis was supplied with red coral. It will be seen that it closely resembles the one which is made of the red and white coral. Fig. 17. Case made of broken pieces of green glass. Fig. 18. Case formed of cornelian. Fig. 19. Case made of broken pieces of shells. Fig. 20. Case from the river, which consists of small stones with one stick attached. Fig. 21. Case of caddis-worm as taken from the river. There is a cherry stone attached to one side of the case. Fig. 22. Case of caddis made of small stones, to which is attached a long strip of wood.

KEW OBSERVATORY.

It is not always necessary to go to a distance in order to meet with something new, and there are institutions in the midst of us which, from the nature of their work, are comparatively unknown.

Those of our readers who have rambled over the Kew Gardens, or have pleasing recollections of a sail up the Thames on a sultry summer's evening, may perchance have observed, towards Richmond, a building which stands alone in the old Deer Park. Perhaps, also, their curiosity has been aroused by three obelisks, one to the north, and two to the south of the said building, which form a constant source of speculation to the inhabitants of the neighbourhood. These are meridian marks for astronomical instruments, and the building to which they belong was originally the private observatory of George III. Here he spent many of his leisure hours in regarding the heavenly bodies and in other scientific pursuits, while even to this very day reminiscences of the old king linger about the place. The observatory is built on a mound, which raises it somewhat above the level of the park, and is surrounded on all sides by vaults, as an additional precaution against the entrance of moisture from the river. It is not now devoted to astronomy, but the Queen having granted it for the use of the British Association, it is employed by that body for purposes connected with physical science.

Although called the Kew Observatory, the propriety of this appellation is somewhat questionable, since it is really nearer Richmond than Kew; but we all know that it is not easy to change a name.

A committee of the association, men of eminence in science, form the board of directors, and have the power to appoint a superintendent and staff of assistants, who by a wise arrangement are guided rather than trammelled by the supervision of the Board.

The past history of this institution under the British Association is indelibly associated with the names of Ronald and Welsh. The former of these, well known as an electrician, was one of the first to suggest the idea of an electric telegraph. He had also, for a considerable time, instruments of his own construction in operation at Kew observatory for the purpose of ascertaining the electricity of the air, and this branch of knowledge is much indebted to his inquiries.

It is perhaps, however, in his employment of photography for the purpose of recording meteorological phenomena, that he has been of the most signal service to science. Here he was

one of the first in the field, and if his processes have since been improved by Brooke, Welsh, and others, he has at least the credit of first pointing out the capabilities of this wonderful agent. His original barograph is even now in use at the Kew observatory, a similar instrument is in operation at Oxford, and another will shortly be elected at St. Petersburg.

Mr. Ronald was succeeded in his office by Mr. John Welsh, whose untimely death has been much regretted, but who, notwithstanding his short career, left a name well known among magneticians and meteorologists. He was the pioneer in those scientific balloon ascents, which have since been pursued in so indefatigable a manner by Mr. Glaisher, and from the very complete arrangements which he was the means of introducing at Kew for testing barometers and thermometers, as well as from his improvements in magnetical instruments, his name is deservedly known, and his judgment highly respected. But we must now hasten to inform our readers of what goes on at present at the observatory, and even to him whose motto is *cui bono* we hope to demonstrate the use of the institution.

We have already stated that the Kew observatory is physical rather than astronomical, and we may now add that the branches of science to which the labours of the staff have been hitherto most devoted are meteorology, magnetism, and heliography, and these have received an amount of attention which could not easily have been bestowed upon them by any private individual. To begin with meteorology. It was only when the great practical importance of this science first began to be perceived, that accuracy in the construction of barometers and thermometers was at length regarded as absolutely essential to the progress of our knowledge.

It is difficult for any one living in these latter days of accurate inquiry, who has, perhaps, only handled the delicate and exquisite instruments which are now constructed by opticians, to realize the inaccuracy and slovenliness with which the indispensable barometer and thermometer were constructed not a great many years since. We have all heard with a smile of Sir W. Armstrong's village hostess, who was afraid her weather glass was not exactly right, for all the quicksilver had run out of it; but we can hardly believe that twenty years ago many opticians who, perhaps, esteemed the presence of mercury essential to the barometer, yet took little pains to measure accurately the length of column of that fluid. We should also like to know how many observers in those dark days ascertained the temperature of their mercury.

Then again with thermometers. Was the atmospheric pressure always noted when the boiling point of an instrument was marked off by the optician, or could either optician or

observer give a satisfactory definition of that point? Was either aware of the gradual change which takes place in a thermometer by age; or in graduating an instrument, was any allowance made for the unequal diameter of the bore at different parts of the same tube? These and other questions might well be asked; nor do we err in stating that errors in barometers of that period might often be reckoned by tenths of an inch, errors of thermometers by degrees.

But day was now beginning to dawn, the public were gradually becoming aware of the practical importance of meteorology; the laws of storms (for even storms have laws) were more observed, and while Admiral Fitzroy applied himself to the task of foretelling weather, the Kew committee set themselves to that of improving instruments; for in the peaceful as well as in the warlike arts, one man furbishes the weapon which another man wields.

It was at this stage that the committee were fortunate in securing the valuable co-operation of the late Mr. Welsh as superintendent of the observatory. One of their first acts was to recommend a pattern for barometers to be used at sea, and instruments after their model have since been very extensively employed by Admiral Fitzroy in the department under his control.

Another important point was to obtain at Kew the means of readily determining the errors of meteorological instruments, previous to which it was essential to construct an accurate standard barometer, to which all others might be referred. Let not our readers imagine that this was an easy task, for in order to avoid the influence of capillarity, it was necessary that the internal bore of the tube to be filled with mercury should be at least one inch in diameter. This, after much preliminary difficulty, Mr. Welsh accomplished, by a method which obviated the trouble of boiling the mercury in the tube—in all cases a difficult operation, but with a tube of such a bore nearly impossible.

Having procured their standard of reference, something more was, however, wanting before barometers could be properly tested; no doubt, by suspending instruments in the same room with the standard, the errors of these might be obtained, but only for the existing atmospheric pressure, whatever that might happen to be at the time of comparison. But for marine barometers, with no cistern adjustment, it was essential to know the error at various points, and clearly it would not do to wait for a storm in order to compare together instruments at a low pressure, or for exceptionably fine weather, in order to compare them when the pressure was high.

Evidently the only plan was to obtain the means of pro-

curing at will an artificial atmosphere, which was accomplished by the successful construction of a receiver, with plate-glass windows, into which an additional inch of air might be introduced, or from which three inches might be abstracted. The comparison might thus be made between 31 and 27 inches, a range which comprehends all weathers.

In the next place, with regard to thermometers, the committee undertook to supply all Fellows of the Royal Society, and members of the British Association who chose to incur the necessary expenditure, with standards of their own construction, and such were likewise supplied to the leading opticians, becoming in their hands, as it were, the parents of a host of accurate thermometers. Nor did the labours of the committee end here, for besides thus indirectly supplying the public with a better description of instrument, great facilities were afforded for the verification of all thermometers which might be sent to Kew. By way of variety, let us here give a short sketch of the method employed in constructing a standard thermometer. Our readers are well aware that in every such instrument there are two points which must be accurately determined before graduation, the first of these being the melting point of ice, and the second the boiling point of water.

Let snow or pounded ice be put into a wooden box, and left for some time in a room, the temperature of which is about 32°, and further let the water which forms be allowed to drain off through a few small holes in the bottom of the box. Now introduce your thermometer tube, which had better be an old one, into the mixture, and when it has remained there for some time, make a mark on the tube at the termination of the mercury. This point must denote 32° if you intend making a Fahrenheit thermometer.

But if the melting point of ice be constant, not so the boiling point of water. Were the pressure of the air to fall to 29 inches, water would boil at 210½°; were it to rise to 30½ inches, the same fluid would boil at 213°. The barometer must, therefore, be consulted when the upper point of the tube is marked off, and not only must the bulb, but also the whole column of the instrument up to the termination of the mercury be immersed during the operation in boiling water, or what is better still in the steam which escapes from it into the air.

When you have thus obtained your two points, say 32° and 212° of the capillary bore of your tube be constant throughout, you have only to divide the distance between these into 180 equal parts. But if the bore, as is always the case, be not uniform, you must make your degree longer when it is narrow, and shorter where it is wide; you, therefore,

require to know the relative diameter of the bore at all the different parts of the tube. In order to obtain this information, a small portion of mercury, sufficient to occupy about half an inch of the bore, is detached from the main body of the fluid in the bulb by a mechanical process, and is made to travel down the tube from the bottom to the top, its length being accurately measured at every stage. Of course where the bore is wide the length of this detached column will be small, and where the bore is narrow, its length will be great. By this method the diameter of the bore is ascertained throughout, and the instrument graduated accordingly.

The result of the labours of the Kew committee was soon apparent. The slovenliness with which meteorological instruments had hitherto been constructed gave place to accuracy, and such are now produced by many opticians with hardly any perceptible error. But here let me impress upon all those who desire perfection not to remain content with the general reputation of the optician whom they employ, but to have their instruments verified at Kew, and a table of corrections procured from that establishment. By doing so, not only is the instrument itself rendered practically equal to a standard, but the optician is kept *up to the mark* by the knowledge that his work is scrutinized. It is now time to notice shortly the various scientific processes which are conducted at the observatory. That meteorological observations are regularly made at Kew, our readers are well aware; and here we may likewise mention the fact that Robinson's anemometer has been improved by Bukly, the mechanic of the observatory, into an instrument which records continuously the direction and velocity of the wind, and which is now extensively adopted. But perhaps the most important processes are those connected with photography. Light plays a very prominent part at Kew. By means of this agent, the changes which take place in the magnetism of our globe, as well as those which take place in the electricity, and the pressure of the atmosphere, are continuously recorded, and, besides all this, the sun is made to take his own likeness.

We cannot here enter into details of construction, let us rather inform our readers what such instruments have already achieved, and what more they may be expected to accomplish. Of the self-recording instruments at Kew the magnetographs are perhaps the most important, and the records of these in the hands of General Sabine have already led to very interesting results. Our readers may be surprised to learn that nothing in nature is more inconstant than the magnetic needle; not only has it a motion depending upon the hour of the day, but it has likewise a change from season to season, and from year to year.

It is influenced by sun and moon, but above all it is subject to sudden and abrupt fluctuations called disturbances, which are invariably accompanied by auroral displays, and by electric currents, which affect our telegraphic wires. The laws which regulate all these motions are best discovered by means of self-recording instruments, and besides investigating these, General Sabine has traced from the records at Kew, and elsewhere, a curious bond of connection between sun spots and magnetic disturbances, two phenomena very unlike each other, but which, nevertheless, have their epochs together.

With regard to the nature of this singular connection we are yet in the dark, but we think the Kew records have thrown some light upon that other bond which links together magnetic disturbances, earth currents and aurora. Men of science abroad are now much alive to the importance of such instruments, and magnetographs similar to those at Kew are already in operation at Lisbon, and will shortly be so in America and Java, in Coimbra, St. Petersburg, and Florence. In illustration of the value of these when all are at work together, we may state that by comparing the Lisbon records with those at Kew, it has already been found that magnetic disturbances break out at precisely the same moment of time in both those places.

We shall now shortly allude to the barograph, another of the self-recording instruments at Kew. By it the changes in the barometer are continuously recorded. Similar instruments are in operation at Oxford and Greenwich, and by means of these it has been found that during sudden squalls the crisis of a storm takes place at Oxford about 50 minutes sooner than at Kew, and at Kew somewhat sooner than at Greenwich. When such instruments are more widely spread, a great increase in our knowledge of storms may surely be expected.

The Kew photoheliograph is already familiar to most of us as the instrument by means of which Mr. Warren Delarue succeeded in obtaining photographs of the sun during the total eclipse which took place in Spain on July 18, 1860, and by which he proved the connection with our luminary of those mysterious red protuberances which are visible on such occasions. The instrument has since been mounted at Kew under the superintendence of this distinguished astronomer, and much curious information with regard to sun spots may be anticipated.

In addition to all this work, monthly observations of the magnetic needle are made in a small building detached from the observatory, so as to be beyond the influence of iron, and scientific men proceeding abroad, with the view of observing the needle at various places, have an opportunity of getting their instruments tested at Kew, and of their receiving instruction in the science of magnetism. By this means we are not only

brought nearer day by day to that great scientific consummation, a theory of terrestial magnetism, but the practical importance of knowing accurately the behaviour of the needle at the different parts of our globe is patent to every one.

The Kew committee have likewise lately introduced an arrangement by means of which sextants, quadrants, and other geographical instruments may be verified, but we forbear to enter further into this interesting subject at present.

While we have thus imperfectly described the chief processes at Kew we have not even yet exhausted the work of the observatory. As it is an institution for the determination of various points in physical science, new problems of importance are taken up as they present themselves. We have elsewhere noted the fact that Mr. Gassiot's magnificent spectroscope is at Kew, and we shall now conclude by expressing our belief that it will not be allowed to remain idle during the fine summer weather which we hope is near.

THE EARTH AS SEEN FROM THE MOON.

M. Camille Flammarion gives the following account of the appearance the earth must present to the inhabitants of the moon :—

"The inhabitants of the moon perceive in their sky a gigantic star, constantly immoveable at the same height. To their eyes this globe is twelve times as large as the sun, but it differs from all the stars in being always suspended in the same place over their heads. It presents phases to them as the moon does to us, passing through all the gradations of new and full earth. This star, as we have just said, is the earth that we inhabit.

"Those who dwell in the centre of the lunar disc behold our globe suspended from their zenith hovering eternally in the midst of the starry skies. Others see it at 70 degrees of elevation, others at 45 degrees, as they inhabit spots more or less removed from the centre of the visible hemisphere. Those who live near the borders of this hemisphere see our globe on their horizon resting on the mountains. A little further on only half the earth is discernible, and in passing to another hemisphere the view vanishes for ever.

"If we except the determination of longitudes, the earth is more beautiful and more useful to the moon than the moon is to the earth, and if the Selenites* rolling beneath us interpret the law of final causes with as much partiality as we do,

* Selenites, from selene (Σελήνη), the moon, inhabitants of that orb.

they will have a right apparently superior to our own for regarding creation, the earth included, as especially made for the Selenian race.

"The earth is a gigantic globe, sending them thirteen times more light than the full moon transmits to us. It revolves on its axis in twenty-four hours, and during this period exhibits all portions of its surface, being thus more generous than the moon, which always conceals one hemisphere from our view. In consequence of this motion, the Selenite finds himself in an observatory magnificently situated for viewing the terrestrial disc, and his position is preferable to that of the inhabitants of the first four moons of Saturn, who can never see the whole of that planet, and they can see the earth better than we see any planet.

"The earth generally presents to them a greenish hue, in consequence of the immense quantity of water by which its surface is covered, of the forests of the new world, and of its plains, and also on account of the tint of its atmosphere. From time to time, however, large grey or yellow spots divide the sphere. To the east of the terrestrial disc appear the lofty Cordilleras, marked by a long indented line, just as we see in the lunar Carpathians to the west of the Sea of Storms. Opposite this ridge, a shady green spot of great extent unfolds itself for many hours—this is the great ocean. Next come two grey patches, which look like one, elongated; these are the two isles of New Zealand. Then appears the fine continent of Australia, tinted with a thousand colours, and accompanied by New Guinea, Borneo, Java, and the Philippines. At the same time the grey country of Asia is unrolled, and extends to the white steppes of the pole. Africa then comes in view, divided by its milky way of sand. To the north of the great Sahara, appears a little green spot torn in all directions, and full of ramifications—this is the Mediterranean; above which those who have good eyesight will discern little, and almost invisible, France. Then the dry land will disappear, and the great dark spot of the Atlantic will follow the same revolving course. The Selenites who carelessly contemplate in tranquil nights the green and grey divisions of the earth, will have no idea of the contests in which the distant nationalities are involved.

"The earth is a permanent clock to the inhabitants of the moon, and this is not its least utility. By reason of its invariable movements the fixed points which mark the different longitudes will be the hours on the meridian of the moon. Each country of the globe has its peculiar aspect, and may serve for a point of departure. . . . .

"The phases the earth presents to the moon will, in the

same manner, serve as an almanack, and we may believe they form its chief foundation. These phases are complementary to those which the moon presents to us: when it is full moon for us, it is new earth for the Selenites; and when they give us a new moon, we offer them a full earth. No reciprocity can be more perfect and constant.

"But the phases of the earth differ essentially from those of the moon, inasmuch as their intensity, not their magnitude, changes perpetually. This phenomenon is very terrestrial, and we may be sure the Selenites have judged us by it long ago. Whilst with them all is calm, identical, constant, with us everything changes. Besides the different lustre of different parts of the terrestrial sphere, green continents, blue seas, yellow deserts, white poles, and grey lands, our atmosphere is in perpetual commotion. One day it is covered with clouds, and transmits to the moon a uniform white light, the day after it is of limpid transparency, and allows the solar light to fall upon absorbent green surfaces. All of a sudden it will be varied with flocculent mountains, and varied mosaics. Thus the light the Selenites receive from the earth, the light which we call 'ashy,' and which we only perceive in the moon's early days, varies continually in intensity.

"This mobility, this perpetual variation in the aspect of the earth, will have made the Selenites believe that the earth is uninhabited. But on what grounds would they form opinions unfavourable to its habitability? They live on a solid and stable sphere, and can see nothing like it on the earth. Can any rational creature live upon that permanent atmospheric layer which covers all the earth? A Selenite who fell into it would be drowned. Can it be on that sheet of green that washes the greater portion of the earth? Can it be on those clouds that appear and disappear a hundred times a day? And then the earth turns with such velocity; it is subject to so much elemental instability! Moreover, can we believe that its inhabitants are people without weight, preserving, no one knows how, a mean position between the fixed and mobile elements? How can such existences be believed?"

Having thus sketched out the probable effect of the earth upon the Selenites who see it rolling over them, M. Flammarion considers the position of those who live on that lunar hemisphere which we never see, and which never sees us. He distinguishes the Selenites as *Subvolvians* and *Privolvians*,* and points out the totally different kind of beings that may inhabit

* These not very judicious names designate the inhabitants of the two lunar hemispheres, one seeing our globe over their heads, and the other not seeing us at all. In reality it is not a whole hemisphere; but $\frac{3}{7}$ths of the moon that is permanently hid from us.

the two hemispheres, if, as is possible, the one we do not see, possesses water and air. After some other remarks he observes, that the astronomy of the Selenites must appear so complicated as to require the greatest penetration for its true explanation. "They behold themselves motionless in the centre of the universe, they see the sun perform its circuit in 29½ days, and the stars in 27¼ days. Those who see the earth will perceive that although it appears almost immoveable in the same part of space, it goes round the sky in 29 days. They would ascribe these movements to the sky and to the earth. As for thinking that they moved, and that this earth was the centre of their movements, and that the sun was the centre of those of the earth and planets; this is a notion to which it would be extremely difficult for them to attain. Celestial appearances are not so complicated as seen from any star as from the satellites."

"Less favoured than the Subvolvian Selenites, who in their transition from day to night pass only from an intense to a feeble light, the Privolvians have a complete night of fifteen days. It follows from experiments of Bouguer, M. Lambert, and even from the theory of Robert Smith, that the mean relation of solar to lunar light is as 300,000 to 1; the mean relation between sun light and full earth light for the Selenites would be as 23,000 to 1. Those who inhabit the opposite hemisphere will have no illumination during their night. But perhaps under their unknown atmosphere they light up artificial suns for half the year; perhaps nature furnishes them with a special illumination, like the Auroras that illuminate our polar regions; perhaps their eyes are constructed for nocturnal life; perhaps they sleep like marmots during their dark winter of half a month. These are all *may bes;* but we cannot doubt that nature has established the Selenites comfortably in their homes; and if one of them came here for the winter he would be astonished with the enormous terrestrial globe that gives us a profusion of day and night, and, like a great child, makes us play at hide and seek all our lives."—*Cosmos.*

RECENT MICROSCOPIC LITERATURE.*

In the last annual address of the President of the Microscopical Society of London, Mr. Brooke stated, "that no foreign microscope that was exhibited (at the International Exhibition) was at all comparable, either in the convenience of its mechanical or the perfection of its optical arrangements, with the instruments of our best makers." This has been the case pretty uniformly since the application of the achromatic principle to the construction of the microscope; but it is only recently that our opticians have successfully competed with the French in the useful task of giving a serviceable, though second or third-rate instrument, at a low price. At present, it would appear that if optical and mechanical excellence, both carried to the highest degree of perfection, be sought for, they will be found in the workshops of our own great makers; while no foreign artist whose productions we have seen appears to give so much for a little money as can be obtained in the educational and student's microscopes of Smith and Beck, Pillischer, Baker, Parkes, and many others whose names are familiar to all who have paid attention to this branch of manufacturing industry and scientific skill. Almost the only feature in foreign instruments which Mr. Brooke commends to the attention of English makers is the correction of certain objectives for immersion in water, a form of construction in which M. Hartnack, who exhibited in the French Department, excels. Mr. Brooke thus remarks upon these glasses:—"A plate of water should intervene between the objective and the covering-glass of the object. From the increased facility of transmission of the oblique rays through a plate of water, the quantity of light under any given condition of illumination is obviously increased." He adds, "With a $\frac{1}{12}$th objective of moderate angular aperture, which is corrected for immersion in water, I have, I think, in some instances obtained better definition than by any other means." From these remarks it will be seen that the film of water makes a small angled glass work like a larger one, and although there may be some rare occasions in which the plan deserves a preference, it cannot be so generally useful or advisable as that which our opticians have so successfully carried out.

Mr. Brooke expresses himself strongly, as Dr. Carpenter did long ago, on the question of angular aperture, which, he

* *L'Etudiant Micrographe.* Par Arthur Chevallier. Paris: Delahaye. *On Preparing and Mounting Microscopic Objects.* By Thomas Davies. Hardwicke.
Quarterly Journal of Microscopical Science. No. xiv. Churchill.

affirms, cannot be pushed to extremes without sacrifice of penetration. We believe Mr. Lister has worked out this subject more completely than any one else, and we think we are right in saying that, omitting mere surface markings of the most troublesome diatoms, rules could be laid down showing the most advantageous proportions in which angular aperture and focal distance should stand to each other to ensure the greatest accuracy of definition. This subject is of great practical importance, and we regret that Mr. Brooke's anniversary address was not more explicit in dealing with it.

The best mode of obtaining great amplification depends in no small degree upon the angle of aperture question. Suppose, for example, a power of 1500 or 3000 linear is required for the exhibition of minute structure. How is it best obtained? Mr. Brooke gives a preference to lengthening the body of the instrument, over the employment of very deep eye-pieces; but upon the subject of deep objectives his statements do not coincide. In his notes on the microscopes of the Exhibition, he tells us that "no objective yet manufactured for sale at all rivals in its power of development the $\frac{1}{25}$th of Messrs. Powell and Lealand," and in the presidential address we find the contradictory assertion that he "has not hitherto succeeded in developing any point of organic structure with Powell's $\frac{1}{25}$th that is not equally visible with $\frac{1}{12}$th by Ross." If $\frac{1}{12}$th of Ross and $\frac{1}{25}$th of Powell and Lealand were selected as of equal merit in workmanship, it would still be found that they differed considerably in the proportion which their angles of aperture bore to their focal lengths; and it is difficult to believe that the two proportions are equally advantageous. Messrs. Powell and Lealand's exquisite $\frac{1}{25}$th is much more limited in its range of utility than their $\frac{1}{12}$th, because the latter will work through thick covering glass, while the former requires it to be so extremely thin as scarcely to bear a touch. Messrs. Smith and Beck's $\frac{1}{20}$th, which has a moderate angle of aperture, is as generally applicable as a $\frac{1}{12}$th or a $\frac{1}{8}$th; and this constitutes no small proportion of its merit. Mr. Ross's $\frac{1}{12}$th, as stated in his catalogue, has an angular aperture of 170°. Working angles of aperture are nearly always *much* less than those calculated by opticians; but suppose Mr. Ross made a $\frac{1}{20}$th of the same working angle, or less than that of his $\frac{1}{12}$th, it does not seem possible that when used to obtain the same amplification, they should both be equally advantageous in point of penetration. We have tried and admired Ross's $\frac{1}{12}$th, and that of Powell and Lealand; but when it is desired to see the interior structure and movements of small objects, such as desmids or infusoria, it cannot be a matter of indifference whether a given magnification is obtained by a deep objective of moderate angle,

without the draw-tube, and with a first eye-piece, or with a lower objective of actually larger angle, with a deeper eye-piece, or with a few inches of draw-tube.

We have heard an experienced microscopist speak as Mr. Brooke does in one of his conflicting remarks, that he could see all with his $\frac{1}{12}$th that he could see with his $\frac{1}{25}$th; but it appears to us that this question wants carefully working out with especial regard to penetrating power. When an object—other than diatom lines—has been seen with a $\frac{1}{8}$th or $\frac{1}{12}$th, can it not nearly always be shown by $\frac{1}{5}$th? A good $\frac{1}{5}$th will work well up 700 or 800 or 1000 linear, and most things that can be seen with 2000 linear can be made out with half that power when their existence is known.

We are abandoning excessive angles of aperture in this country, and the Americans are resorting to them. This will give rise to inquiry as to the value of their observations, and when such observations necessarily require penetration, accompanied by fine definition, we should be disposed to doubt the correctness of the appearances brought out by objectives in which the angle of aperture was very large in proportion to focal length.

So long as microscopic students are merely engaged in laying the foundation for original inquiry it may be doubted whether they will do any good with a magnification of more than 500 linear, but when original inquiry begins, high powers become indispensable, and the best mode of obtaining them is an important consideration, on which we should recommend new and careful experiments to be made.

Passing from points which experienced microscopists are alone qualified to discuss, we come to subjects of more general interest, and congratulate Mr. Davies on the aid he has afforded to microscopic students by his compact work on preparing and mounting microscopic objects. His book is necessarily and avowedly in the main a compilation, but the reader has also the advantage of the author's personal experience, and will derive much information, not only with respect to different methods of mounting, but likewise concerning the treatment which particular objects require. The instruction ranges over a wide field, comprehending diatoms, desmids, sections of organic and mineral substances, anatomical preparations, dissections, etc., and the directions are given in a clear, agreeable style.

In mounting objects it is customary to use Canada balsam thinned with spirits of turpentine or camphine; but it is often desirable to obtain the resinous matter in a more liquid and volatile solution. One good plan is to dissolve thick balsam in wood naphtha, or pyroligneous ether, which is by far the best

solvent for cleaning slides. Another plan is to use chloroform, as Mr. Davies thus describes:—"The balsam is exposed to heat until on cooling it assumes a glassy appearance; it is then dissolved in pure chloroform until it becomes of the consistence of thick varnish. This liquid is very convenient in some cases, as air bubbles are much more easily got rid of than when undiluted Canada balsam is used. It also dries readily."

We shall make one more extract from Mr. Davies, relating to the treatment of the Equisetaceæ, which are now growing in easily accessible places. He is speaking of their preparation for the polariscope, and tells us, "Some of these plants, including many of the grasses and Equisetaceæ (*i.e.*, horsetails), contain so large a quantity of silica, that when the vegetable and other perishable parts are removed, a skeleton of wonderful perfection remains. This skeleton must be mounted in balsam, the method of preparing which will now be considered."

"Sometimes the outside of the Equisetum is removed from the plant, others dry the stem under pressure, whilst the grasses of course require no preparation. The vegetable should be immersed in strong nitric acid, and boiled for a short time; an effervescence will go on as the alkalies are being removed, and when this has ceased more acid should be added. At this point the modes of treatment differ; some remove the object from the acid, and wash, and having dried, burn it upon thin glass until all appears *white*, when it must be carefully mounted in balsam. I think, however, it is better to leave it in strong acid until all the substances, except the required portion, is removed; but this will take a length of time, varying according to the mass, etc., of the plant. Of course, when this latter method is used, the skeleton must be washed from the acid, etc., before being mounted in balsam."

M. Chevallier's book is an effort, on a smaller scale and less comprehensive plan, to do for French students what Dr. Carpenter's work on the microscope has accomplished for our own. From his pages we conclude that many desirable accessories for the illumination of both opaque and transparent objects that are commonly employed in England are little used in France, and the chapter on Test Objects, mainly founded on experiments so old as those of Dr. Goring, would not in this country be considered up to date. The student is taught, for example, to be satisfied with a definition of the Podura scale, far below what would be given by a fair second-rate quarter-inch of English make.

M. Chevallier recommends distilling a liquid from Canada balsam, in order to obtain a fluid well adapted to thin other specimens of the balsam, or to soak objects in, that are intended to be mounted in it. He likewise recommends a

varnish made by dissolving copal in essential oil of lavender. A drop of this varnish is placed on the slide, the object laid on it, covered with thin glass, and set aside in a warm place for a few days. Another varnish, which he affirms to give excellent results, is composed of—

Canada balsam	30	grammes.
Tears of mastic, powdered .	10	„
Chloroform in sufficient quantity.		

The chapters on preparing objects are very good, but most of the information is the same as that given in Mr. Davies's work. M. Chevallier, as the latest contribution to this subject, gives the following process, modified from that prepared by Mr. Leador of Philadelphia. He says, "I have lately tried a new compound which has given very good results, with Naviculæ and other delicate objects. Here is the formula:—In 30 grammes of chloroform dissolve 1 gramme of caoutchouc. When the solution is effected, add tears of mastic until a syrupy or demi-syrupy consistence is obtained." The object is put in a drop of this solution on a slide, gently pressed and allowed a day to dry, after which the edges of the covering glass are varnished. It is said to be perfectly transparent and unalterable.

Before leaving the subject of mounting, we must allude to Mr. Freestone's new mounting-table, described by Mr. Goddard in the *Quarterly Journal of Microscopic Science* for April, 1864, p. 45. The object of Mr. Freestone's invention is to dry and harden slides rapidly, without injury to the objects.

"It consists of a plate of brass 12 inches by 3, and one-eighth of an inch thick. Upon this, two pieces of metal of the same thickness, and 12 inches by 1, are riveted, leaving a clear space one inch wide in the centre of the plate; the whole being supported on tubular legs seven or eight inches high." The slides are laid across this table, which is heated by a spirit lamp underneath, and from the form of the table the part of the slide containing the object does not touch the brass plate, but is heated by conduction, radiation, and by currents of hot air. Mr. Goddard states that delicate sea-weeds, such as Plocamium and Cladophora, can be mounted in balsam by the aid of this apparatus without losing their colour.

We do not observe in M. Chevallier's work many allusions to articles of apparatus not well known in this country; but the "variable objective" invented by his father we have not had an opportunity of seeing, and, from the description, it might be very handy. "It is composed of two brass tubes sliding one in the other; and at the extremity of each tube is an achromatic lens of long focus. . . By means of the

sliding tube, the two links may be separated or approximated so as to give a greater or smaller magnification."

M. Chevallier's work is, in many respects, well executed; but we regret that in describing the Infusoria he follows the classification of Müller, according to which rotifiers are confounded with the vorticellids, because both make whirlpools by means of their cilia, a fact not quite true of the flosculariens, and which, taken by itself, affords little clue to either affinities or structure.

EXOGENOUS SEEDS AND FERN SPORES.*

BY R. DAWSON, M.B., LONDON.

(*With a Tinted Plate.*)

Balfour, in his *Manual of Botany*, says, "The embryo varies in its structure in different divisions of the vegetable kingdom. In Acrogenous and Thallogenous plants it continues as a cell or spore, with granular matter in its interior, *without any separation of parts or the production of cotyledons.* Hence these plants are called Acotyledonous."

Further on he says, "The spore of Acotyledonous plants is a cellular body, from which a new plant is produced. Germination takes place *in any part of its surface*, and *not from fixed points.*"

Moore, on *British Ferns*, defines spores much the same; describing the determined points in seeds, the cotyledons, the ascending and descending axes, and then, contrasting the development of ferns' spores, says, "On the contrary, they consist merely of a small vesicle of cellular tissue, growing *indifferently* from any part of its surface" (*Hand-book of British Ferns*). Carpenter on the *Microscope*, Lindley's *Vegetable Kingdom*, etc., all have a like idea. The above, then, is the received opinion of the present day relating to the growth of the fern spore. See also Hofmeister's elaborate work, published by the Ray Society.

These same high authorities also state and believe that ferns germinate by bodies called antherozoids or males, coming into connection with archegonia or females, and this occurs on the first-formed body from the spores, called prothallium.

The first part of these statements, as far as I can learn, has never been questioned; the latter has, though now universally accepted. I proceed to disprove the first statement entirely, and I hope to throw discredit on the last.

A seed in its simplest form, such as seen in the mistletoe,

* This paper was read before the Brighton and Sussex Natural History Society.

is composed of a cell called a nucleus, within which is the germinal sac, containing the germinal vesicle. In the amniotic fluid, attached to the germ sac, is the suspensor. If the mature germ fill merely its sac, the rest of the nucleus is filled with vegetable albumen (see Campanulaceæ), or the germ may fill both its sac and nucleus (see Compositæ).

Now this germ sac is formed by a depression at the apex of the nucleus, the edges meeting; but at the point where they meet is the spot where the future root will make its first appearance. Whatever coverings may grow over the seed, they avoid this spot, which, in time, becomes a little hole, and called the foramen or micropyle, marking the organic apex of the nucleus. The organic base is marked by the chalaza, where are seen fibro-vascular bundles passing forwards from the funis or umbilical cord to the nucleus.

The hilum marks where the funis joins the seed to the placenta.

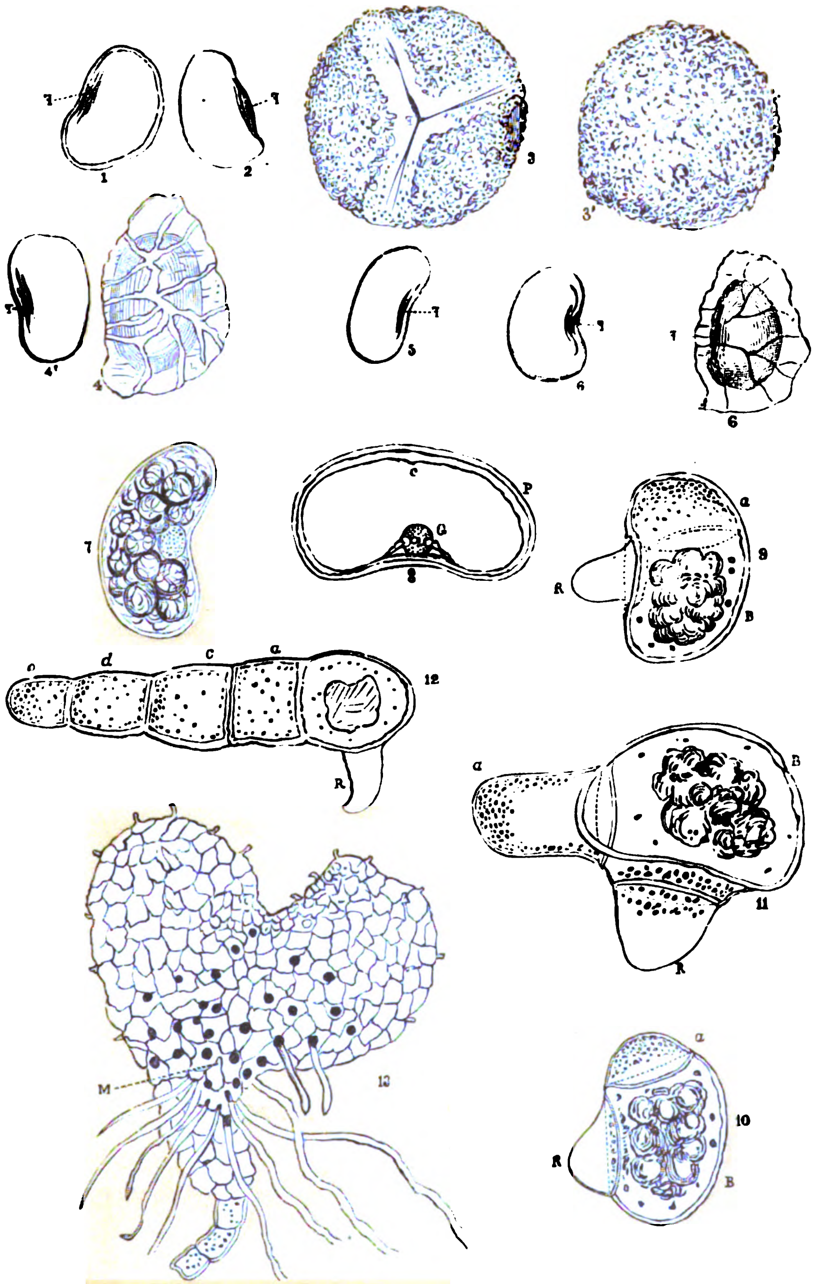
The nucleus may simply be an erect ovule, when the base will correspond with the hilum, or it may make a procession till the apex comes down to the hilum, or may retain any intermediate position. Moreover, the nutrient matter may make a bend on itself, in which case the seed will be said to be camptotropal or curved like a horse-shoe.

Around the nucleus may be coverings, called intine and extine, being developed from its base. Moreover, it may have another covering, as in the mace or spindle-tree, called an arillus, developed from the chalaza or from around the foramen.

A perfect seed, therefore, consists of a nucleus, a germ, and a germ sac, which latter contains the embryo of an ascending and descending axis, together with nutrient matter,. having a foramen of exit and certain coverings.

When a seed begins to grow, having imbibed water, the radix pushes forward through the foramen, and if the coats of the seed be thin, they rupture irregularly from the pressure, so that, at first sight, it would seem as though there were no foramen. While the radix pushes its way out, the nutrient matter within has been undergoing changes: starch becomes, through diastase, dextrine and grape sugar. Meanwhile the germinal spot has arranged itself, and the plumule or ascending axis can be traced; the nutrient matter supplying sustenance to the several parts, as in wheat or barley; or else it forms itself into primary leaves, as in the bean or mustard, not having enough matter in itself entirely to nourish the plumule. Therefore these leaves elaborate matter taken from the ground by the radix, and so indirectly support it.

If the spores of ferns be carefully examined, there will



GERMINATION OF FERN SPORES.

1. Spores of Lastræa dilatata. 2. Spores of L. filix-mas.
3. Osmunda regalis. 3'. Back of same. 4. Polypodium phegopteris. 4'. When young.
5 Platycerium alcicorne, and 7, 8, 9, to 13. 6. Lastræa rigida.
6'. The same young. 7 to 13. Progressive development of Platycerium alcicorne.
A. First new cell. B. Old cell. G. Primary vesicle and germ.
F. Foramen. R. Radia. P. Extine. M. Fern always appears here.

be seen on all markings, such as seen in Plate (Figs. 1 to 7). What are these markings?

If a spore be examined when young and transparent (Fig. 8, *Platycerium alcycorne*), it will be noticed that there is an outer covering and an inner lining membrane filled with clear homogeneous matter, and invariably, near the marking above named, a compound body in a sac; attached to the sides of which, proceeding from the marking to the body, are two small processes if the body be in the centre of the marking, but one, if it be to the side. If the mature spore of the same plant be examined, it will be found, as at Fig. 7, filled with a mass of yellow refractive globules, and the nucleus will with difficulty be made out; but if some reagents, such as glycerine, be added, the globules will become transparent, and the nucleus revealed again. These globules are the homogeneous matter before named, plus other matter imbibed. If a mature spore be grown and watched from time to time, the following results:—The spore swells, at the marking before named a peculiar body appears (R, Fig. 9). This pushes its way through the marking, as seen by the dotted lines, and so the cell is ruptured. This marking proves itself to be a vaginal opening, or, in other words, a foramen (F), and the body which has pushed out, a radix. While this change has been going on, a corresponding alteration has ensued within the spore. At the upper part a cluster (A) of green bodies has appeared precisely similar to those seen afterwards in all the cells of the prothallium, while the globules of matter have shrunk into a mass (E) not large enough now to fill the cell (B). Meanwhile the cells at A have constituted themselves into a new cell (C), excluding B; C takes another cell (D), and this again another, and so on till a body of the form of Fig. 13 is formed, which is called the prothallium. While A has been undergoing these changes, B's matter has wasted entirely away; a few cells, such as seen in A, are within it, but its future destiny is not absolutely traced.

For convenience I will name all these described parts. The spore is a nucleus with a covering; it contains a germinal vesicle in a sac. The opening in the spore covering is the foramen. When the spore grows, the radix forces open the foramen, while the primary germ has been undergoing a change. This reads very like the description of a seed; and the similitude does not merely extend to appearance, but the functions of both are alike. The only difficulty is in the prothallium, which appears, at first sight, to have no analogy in the seed, though, in fact, the cotyledons in the mustard and the prothallium in the fern are identical, answering the purpose of developing the plumule. I have hitherto, as far as

possible, avoided this word cotyledon, and have used nutrient matter, for it signifies not what the form of the matter, its function is the same, viz., directly to nourish the radix, directly and indirectly to nourish the plumule. Now, in the wheat it simply supplies nourishment to both till it is exhausted, being sufficient, all things being equal, to develop the young plant till it is able to gain its own sustenance. But in the mustard it is the reverse; there the nutrient matter is not sufficient to support the radix and plumule entirely, so it changes itself into leaves, whereby matter taken up by the radix may go to the support of the plumule; and this is proved by seeing the leaves in full vigour, when the plumule can scarce be traced. Moreover, when the plumule is once established, these leaves waste and die, or, if they be plucked off, the plumule will not appear. Now the proof that this matter in the spore nucleus is nutrient, is seen in its wasting in proportion as the radix and primary cell develop, during all which time those cells which have to develop into the future fern are quite rudimentary, and not traced for a certainty as yet. Now the mustard cotyledons are only the rudiments of the two cotyledonary leaves, for it can be seen that these latter grow. But the prothallium is but an elaboration of the cell (A), derived from the nutrient matter (B). The question is one, therefore, only of degree; and if mustard has one or more cotyledons, the spore must have the same. We need no fanciful resemblances, or else, to look at the prothallium, we could imagine two cotyledons in one. I have said that a seed has a suspensor; I have pointed out bodies attached to the primary vesicle of a like kind. Moreover, seeds have an arillus or extra covering. Figs. 4 and 6 show a covering around many kinds of spores. 4' 6' mark the appearance of young spores of the same kind, showing that, at one stage of existence, the spore has not this covering; in fact, every intermediate stage may be seen.

It can be clearly demonstrated that, at the point F, which marks the foramen, the hilum also exists; but the analogy between a seed and a spore is, I think, sufficiently perfect. What have I done then? I have made my fern to partake of the nature of a flowering plant minus the flower. And now one word as to *filicial sponsalia.* Where is the marriage-bed?

Flowers have an infancy and manhood, and in this last proper time they generate their species. Flowers are not peculiar, animals do the same; in fact, save in one solitary case, throughout animated nature, no individual is said to beget its offspring before its own proper self has any existence. Incredible as it may seem, one plant is believed by all scientific men to-day, to be begotten, to have all its own offspring

pre-begotten and pre-destined, before that solitary individual has made its appearance or *de facto*, is—and that one plant a Fern.

Sumniski and Mercklin affirm, and men believe them, that on the prothallium, before the fern has any being, two bodies exist, male and female; that the males, enclosed in their own proper envelope, live in cells, which from time to time burst, setting free their occupants, which are individuals with a club-head, like a spermatozoa, a spiral tail, and six cilia at the head; that the females are small pyramids of cells, having at the bases the germinal spot, at the apex an opening; that the males enter the pyramids, and passing down a straight tube, effect the conjunction required; that from this spot the future fern grows, already pre-destined and pre-impregnated for the years or ages of its life.

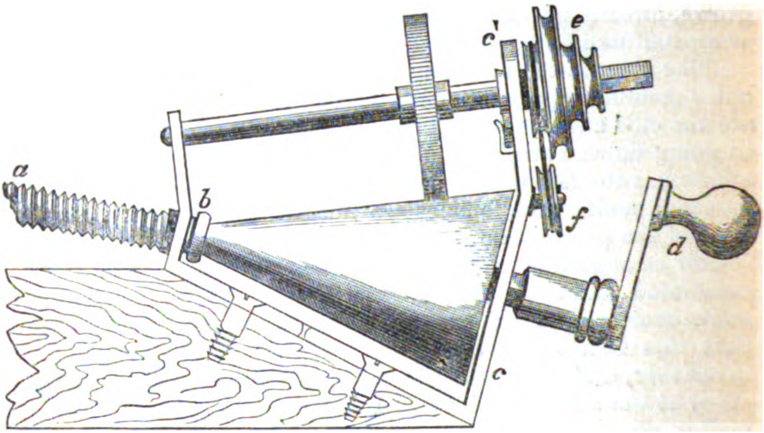
The story is too romantic, the compromise between animal and vegetable impregnation too obvious to be real; besides, what are the cilia and curved tail for, impediments rather than aids to going down a straight tube, and cilia are for swimming, but where has the Leander to swim to his Hero? Moreover, these so-called males and females are not a few, but many, at the base of the prothallium, to the right and left of the centre line—how strange that never more than one female becomes impregnated, and that only one fern results from so much generative matter, and on one prothallium. Again, how strange that this fern which does result, occurs in the middle line invariably, and never to the sides, although females are as many at the sides as middle. I have carefully observed these bodies, which are clearly to a demonstration nothing but roots and stomata in all stages of development; that by the pressure of the covering-glass the contents of the young ones may escape, but that they have tails and whiskers is pure imagination. These same bodies may be seen clearly in the radix from the very outset, and have nothing whatever to do with impregnation; at a future time I will illustrate this more fully. For the present, however, ferns are still Cryptogamia, and their conjunction to be found out; but we have one aid furnished us by this inquiry, a spore is a seed, a seed came from an adult plant, nor was it formed on a cotyledon-placenta. We must look, then, to the adult fern for its two elements, and there we find evidence enough for demonstration.

I have omitted to note the form of the fern ovule: if what is affirmed be true, the cotyledon must be curved on the germ. The foramen and hilum corresponding, we shall, therefore, have a camptotropal ovule. In another paper, I hope to give sufficient evidence of the impregnation of adult ferns, and that occurring where the fruit is found.

STAR FOLLOWING.

BY REV. E. L. BERTHON, M.A.

In the Intellectual Observer for May (No. xxviii. p. 290), a description is given of convenient methods of following the heavenly bodies in their apparent courses, with a telescope mounted on a new table-stand; but as the woodcut necessary to make it intelligible was accidentally omitted, the object of these few lines is to supply that deficiency; and the accompanying illustration is to be understood as belonging to that description.



The reader is also requested to refer to the Intellectual Observer for November, 1863, No. xxii. p. 283, for a drawing and specification of the stand, to which these recent improvements are added.

The writer further embraces this opportunity of offering a few remarks upon the advantages of good stands for astronomical telescopes.

Although equatoreals are becoming daily more common, they will never, for obvious reasons, entirely supersede those possessing horizontal and vertical motions; and to combine these two movements together to produce an even course without vibrations, or a succession of jerks, is a considerable step in the improvement of table-stands and in increasing the effectiveness of the optical instrument so mounted, and the comfort enjoyed in its use.

The two chief desiderata in a stand are—

1st. That it be steady and free from vibrations.

2nd. That the least possible exertion be required to set and

keep it in motion, for in the more delicate observations the observer is often sadly distracted by his efforts, owing to the imperfection of his stand, to keep the object steadily in the centre of the field of view.

It has been remarked by eminent astronomers, that an inferior telescope on a good stand will do more than the best instrument badly mounted; that recommended by the inventor in this and the previous articles, combines the advantages of great steadiness and comfort in use in a high degree. It will be observed that the forces which produce motion both in azimuth and altitude are exerted on the *base* of the stand, and that the tube is never touched; there is, therefore, as little proportional tendency to shake it as there would be to shake a tree by applying force to its roots, instead of seizing its branches. Besides, the telescope is not held by one joint only, but it is actually supported on four trunnions, the long side-arms doing duty as bearers as well as steadying-rods.

Although this construction may not be adopted for sale by opticians as being less portable, and not so easily packed in a case as the pillar-and-claw stand, it will be found very delightful to amateurs, who, if possessed of a little mechanical skill, and with the aid of a joiner and tinman, may erect one for a small sum. The tripod stand for out-of-door service is very much used, but it is not a comfortable arrangement, especially in any of the more delicate observations; if the astronomer stand up he finds it difficult to keep his head steady, and to sit down in the open air is not always pleasant in a winter night.

Mr. Bird in the last number of the INTELLECTUAL OBSERVER, p. 242, remarking upon the almost necessity of comfort to the observer, if he would make anything of minute details in the Stellar or Planetary Orbs, says, "To do any of these things effectively in the open air, with one's telescope agitated by the passing wind and a body shivering with cold, is clearly next to impossible."

The strong recommendation of this gentleman, who has done so much with silvered specula, that amateurs should provide themselves and their instruments with the genial shelter of a cheap observatory, cannot be followed too soon or too generally; but the writer, having the same end in view, hopes that the above-named very intelligent astronomer will pardon him for stating that though cheap, his is not the *cheapest* observatory, he (the writer) having himself erected one for half the money, which he most strongly recommends to the consideration of all amateurs who possess a garden or other ground with tolerable sky-view; it is extremely pretty both externally and internally, and forms a most pleasing ornament to a garden

or pleasure ground. It was built last summer, and answers admirably, being 10 feet clear in diameter inside, and 10 feet 6 inches high to the apex of its roof, which is conical and opens to every part of the sky, from the horizon to the zenith.

Although Mr. Bird's observatory cost certainly very little, £14, that possessed by the writer cost him less than £6, and it might be built anywhere for £7. As the luxury of such a pleasing retreat to the student of the noble science of astronomy is immense, it is presumed that many a shivering *dilettante* would be glad to possess one if put in the way to obtain it for so small a sum. The writer, therefore, would be happy to publish, in a future number of the INTELLECTUAL OBSERVER, if agreeable to the editor, a full description of a cheap and ornamental observatory, such as any village carpenter could build in about a fortnight.

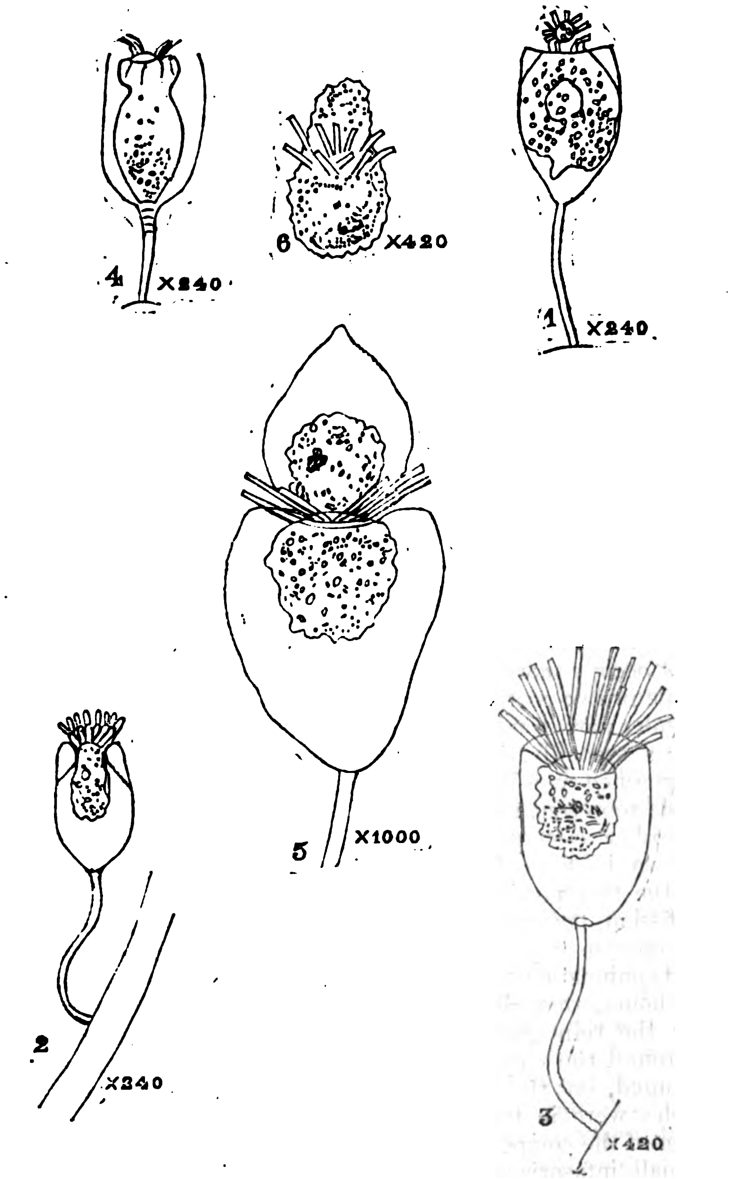
A SUPPOSED NEW ACINETA.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

(*With an Illustration.*)

ON the 22nd April I spent a couple of hours at Budleigh Salterton, South Devon. At this little place the Otter enters the sea, forming, for so small a stream, a somewhat large estuary, which low water reduces to a mud flat, through which the river runs in one principal and some subsidiary channels, the latter, no doubt, subject to much variation. At the time of my visit, one of these little channels, a few feet to the west of the principal one, was full of seaweeds, on which I noticed diatoms growing. A tuft of fine weed, covered with Synedræ, was put into a bottle, and on examination disclosed a number of Cothurniæ, or creatures resembling Vorticellids, but inhabiting elegant glass-like cups, supported on stalks. One of these is shown in Fig. 1. These, although very pretty objects, did not detain my attention, as I had often seen them before; but I was surprised to find in other cups, not in any way to be distinguished from those in which Cothurniæ were living, a creature differing from anything I had previously met with. My first impression, on seeing a row of cylindrical and stiff tentacles, was that I had found a small polyzoon; but, on viewing it with a higher power, I saw that the tentacles were not ciliated, and I could not discern a trace of internal organs proper to so high a group. Polyps the animals certainly were not, and my puzzle increased. The Cothurnian lives in his cup



Explanation of Plate.—Fig. 1. Cothurnian, mag. 240. The horizontal lines at the top of the stalk not seen in all specimens. Fig. 2. Supposed new Acineta, mag. 240. Fig. 3. Another specimen, with tentacles extended, mag. 420. Fig. 4. Another specimen, the sarcode exhibiting apparent remains of a tailfoot. The circle with three dots represents a small boss of sarcode, with three tentacles fore-shortened, mag. 240. Fig. 5. Two individuals, in conjunction (?), mag. 1000. Fig. 6. The sarcode of the above, showing tentacles in two rows, mag. 420.

or bottle in an intelligible way. He stands upon a footstalk, or tailfoot, and jumps up and down as he likes. The new creatures were, on the contrary, suspended near the mouth, as shown in Fig. 2. The cups of the Cothurnians, and of their strange companions, were so transparent, so clean, and so thin near the edges, that their rims wanted careful illumination to make out, and I did not succeed in determining *precisely* how the new creatures were moored. In favourable specimens I saw two delicate lines, as in Fig. 2, which did not, with any power or illumination, look like cords; but which I supposed represented a very fine membrane going all round the animal's body, and probably forming an inversion of the cup rim. The animals were very sluggish; but occasionally the group of tentacles would be retracted, though not perfectly. In this state they were like a row of regular teeth. Slowly they were protruded, generally not more than in Fig. 2, but in one specimen, as fully as Fig. 3, which is drawn on a larger scale. I looked in vain for positive organs in the little granular lump of sarcode that formed the body. At first I thought I made out a contractile vesicle; but I could see no regular expansion and contraction. The sarcode mass varied in details in different individuals. In some, large granules and vacuoles were discernible; in others, both granules and vacuoles were small. Most of them, in shape of body, resembled Figs. 2 and 3, and did not occupy more of the cup. One, however, departed from this rule in two particulars; first, his body was large, and, at the hinder part, was what might be taken for the remains of a tailfoot: secondly, instead of a simple row of tentacles, he had some perched on a boss of sarcode, as shown in Fig. 4, where the dots represent three tentacles fore-shortened.

Another case presented a still more curious peculiarity, as shown in Figs. 5 and 6. There was nothing to determine what the two portions were about. It could scarcely have been fission, because the larger and smaller portions were each in a separate cup or bottle, the upper one having no stalk. Was it conjunction? I do not know. I watched them for about three hours, then checked the evaporation of the water drop under the thin glass cover, by running a little wax from a *vesta* round the edges, and in the morning found the situation unchanged, but the animals apparently dead. In this case the tentacles were in two rows, one apparently belonging to each portion of the compound object.

Small infusoria frequently bobbed against the tentacles, and sometimes large ones; but the creatures remained very sluggish, and made no attempt to capture prey. Jarring the table, suddenly pressing the glass, produced no effect; nor did shifting the cover glass, by moving it laterally with considerable

roughness. On one occasion, a Euplotes, who seemed tormented by the adhesion of foreign bodies, and by some disorder that produced bumps on his surface, made use of one of the new creatures as a sort of rubbing post. This went on for some minutes without disturbing its repose, but at length the tentacles did retract.

I was strongly impressed with the idea that the creatures were transition forms, and could not conceive that the stalked cups were made by them in anything like their present condition, or that they were ever made by and for an inmate who was destined to remain suspended from their mouths, leaving the greater part of the space waste. I thought they were transition forms of the Cothurnians, and still think so, although I could find no positive proof of the correctness of this view. In some Cothurnians, the edges of the cups were prolonged, and in Fig. 4 the new animal filled the cup better than any others which I saw, and it had something like the remains of a tailfoot.

The new creatures varied considerably in size, the most common dimensions being about 1-100″ from the top of the expanded tentacles to the bottom of the footstalk. The stalks were curved, or straight, indifferently, as were those of the Cothurnians. The normal form was, I suppose, straight, and the curvatures accidental.

I have called these objects new, because I cannot find that anything exactly like them has been previously described; but the creatures seen by Mr. Alder in 1851 seem to have been in *some respects* similar, judging from his sketches; though they have been treated as if they differed widely from mine. Mr. Alder's account was published in the Transactions of the Tyneside Naturalists' Field Club, and from thence transferred to the *Annals of Natural History*, 1851, vol. vii., p. 426. His words are as follows: "While examining a specimen of Sertularia taken from the rocks at Whitburn, under the microscope, I was struck with the appearance of what seemed a very minute parasitic Zoophyte, several specimens of which were attached to different parts of the Sertularia. The body was of a vase or cup form, expanded at the top, and set round with numerous pointed tentacles abruptly thickened towards the base, and forming more than one row; they had very little motion, but were occasionally bent forward, and the whole were sometimes slowly retracted. The body was attached to the Sertularia by a tolerably short stem."

In another case he found a smaller one, "the tentacles capitate or knobbed at the end, and not so numerous as in the first." Mr. Alder states that in the first instance he took these creatures for Campanularian Zoophytes; but "found their organization more simple than in true polyps."

It is curious that, as Mr. Alder thought these creatures looked like Campanularian Zoophytes, or animals inhabiting bell-shaped cups, he should have omitted the mention of the cup in his description, and described the "*body* as of a vase or cup form." The tentacles of his objects differed in shape from mine, and were clearly not the same, nor should I have expected any strong resemblance, had I not noticed a copy of his drawings in the *Micrographic Dictionary*, pl. 40, figs. 13, 14, 15, which led me to further research. The drawings, especially 14 and 15, and those from which they were copied in the *Annals*, seem to show that the body of the creature is suspended in a bell-shaped cup standing on a stalk. At first these objects were named Alderia; but that appellation having been pre-occupied, they took their place among the Podophrya and the allied genus Ephelota in the last and fourth edition of Pritchard's *Infusoria*. In this position they were placed, as Mr. Pritchard informs us, by Dr. Strethill Wright. In my specimens certain peculiarities mentioned by Dr. Wright in the stem and tentacles of his Ephelota did not exist. The *Podophrya ovata* and *pyriformis* in Pritchard's *Infusoria*, and especially the former, seem, on the whole, to bear most resemblance to mine.

I have indicated the few points of resemblance between my creatures, which I believe to be *Acinetans*, and those described by Mr. Alder and Dr. Strethill Wright, and through the kindness of the last-named gentleman, to whom I am indebted for an obliging and valuable communication, I am able to state that his two genera, "Podophrya and Ephelota, differ from Acineta in having no cell or cups; but a chitinous solid stem sometimes enlarged at its summit. The internal part of the stem is either transversely or longitudinally striated with lines of growth." This settles the fact that my creatures were not Podophryans; but the distinction between cup and no cup is softened down in one specimen of Podophrya, of which Dr. Wright has favoured me with a sketch, and in which the top of the stem is hollowed out.

Dr. Strethill Wright finds in the neighbourhood of Edinburgh two Acinetans which are something like mine, but obviously not identical; and he informs me that the tentacles are often very obscurely capitate or knobbed at the ends: mine certainly had no knobs; but perhaps the distinction of knobs or no knobs is not always permanent.

GAUTIER ON THE PHYSICAL CONSTITUTION OF THE SUN.

THE *Archives des Sciences*, 20th April, 1864, contains a paper by M. Emile Gautier, reviewing various observations, opinions, and discoveries of eminent astronomers, from the consideration of which he deduces the following conclusions. In giving these and other speculations we may be permitted to remind our readers that they supply a mass of hypothesis worth consideration, but certainly not to be accepted as ascertained fact.

1. "The sun is a liquid globe, incandescent, composed of elements like those which enter into the composition of the earth, and probably into that of the planets of the system. They exist in a state of liquidity, such as the earth passed through, according to the current opinions of geologists.* The high temperature which preserves the elements in a liquid form, necessarily dilates their volume, and explains the relatively small density of the fused globe."

2. "An atmosphere envelops the liquid mass, and holds in suspension vapours and emanations of all kinds, so that the inferior layers may be much heavier than those of the terrestrial atmosphere. The rotatory movement of the central globe need not be supposed to be transmitted to the most elevated regions of the solar atmosphere with the same angular velocity. We may therefore presume that the solar atmosphere exercises an action of rubbing or friction on the globe."

3. "The emanations or metallic vapours surrounding the sun, and impregnated with dust, smoke and lava, form around him a layer of variable thickness, and give rise during eclipses to the red borders and protuberances."

4. "The solar spots are partial modifications of the surface, due either to coolings, or to chemical actions that cause a momentary reunion in masses of salts or oxides issuing from the mass in fusion and floating on the surface. At the end of a certain time—which may exceed a terrestrial year—the chemical action of other elements, or an elevation of temperature, gives rise to new bodies. The dark nucleus of the spots corresponds to the thickest part of the solid crust; the penumbra to the pellicle, which in every formation of this kind is seen on the surface of a metal in fusion, and which is always produced about salt or scoriæ. Both are liable to be cracked, and to form figures through which the brilliant fused mass may be seen in the form of luminous bridges or spots."

* Geologists are not specially responsible for this opinion. Whether true or false, it is not evidenced by the superficial formations with which their labour lies.

5. "The faculæ are the result of the appearance on the sun's surface of substances that are more luminous, or endowed with a more considerable power of radiation. The conditions inherent in the roseate envelope of the solar globe, may also combine to give the surface the flocculent and uneven (*pommelée* and *moutonnée*) appearance which it presents.

6. "The acceleration noticed in the rotation of the spots situated near the sun's equator, is the result of the exterior action of atmospheric pressure on the liquid surface, combined with that of the inferior layers of the mass in fusion. As for the accidental irregularities, ascertained to exist in the movement of the spots, whether in latitude or longitude, they arise from the want of equilibrium, both physical and chemical, existing between the different components of this mass, which cause frequent whirlpools, both in the interior of the globe and in its atmospheric envelope."

THE DIDUNCULUS, OR LITTLE DODO.

BY W. B. TEGETMEIER.

The extinction of several species of the lower animals through the agency of man is a fact that, unfortunately for the interests of science, admits of no dispute. Within the recent period of twenty years that most interesting water bird the Garefowl, or Great Auk, has been persecuted from off the face of the earth; and sixty-three or sixty-four stuffed and dissected specimens are all that remain to prove the existence of one of the largest and most powerful of our diving birds.

The British Museum sample was shot in the Orkneys in 1813, and the last known specimens were captured in 1844, and are preserved in the Museum at Copenhagen. Yet within the memory of old men now living, numbers of these birds existed on the Penguin Islands, near Newfoundland, but they were destroyed for the sake of their feathers. Now that this wanton destruction has been effected every effort is made to procure mutilated skeletons, or even a single bone of a bird in whose cause no hand was held out whilst it was alive; and the few specimens of the eggs that exist in our collections are valued at their weight in gold.

Those of the younger readers of the INTELLECTUAL OBSERVER who may be desirous of saying in their old age that they have seen a living specimen of an animal which will then no longer exist, should haste to the gardens of the Zoological Society to see there a bird that is the first, and will in all probability be

the last, specimen of the Didinæ, or family of the Dodos, that has ever been seen alive in Europe.*

Of the Great Dodo itself no perfect specimen remains. A foot in the British Museum, an imperfect skull at Oxford, some few engravings and paintings of the animal, are all that serve to show the previous existence of one of the largest, and what might have been most useful, of domesticated land birds. Its value as food, and its want of the power of flight, however, rendered it a desirable and easy prey to the earlier voyagers.

Until recently so little was known about the Dodo that its powerfully hooked beak led Professor Owen to place it among the birds of prey, and to surmise that its food consisted of reptiles and crustacea. Some other naturalists regarded it as allied to the gallinaceous group. Within the last few years, however, the more critical examinations of the scanty remains of the Dodo prove, without doubt, that it was a gigantic ground pigeon. This idea will not appear so startling to our preconceived notions if it is borne in mind that, in addition to the slender-billed seed and grain-feeding birds that constitute the group of pigeons and doves best known in Europe, there is a group of powerful hooked-beaked pigeons, feeding on the hard-shelled fruits of palms and firmly-husked tropical seeds, requiring a strong beak to crack the outer shell.

It is to this group that the extinct Dodo and the extant Didunculus belong. The former evidently employed its powerful bill in husking the fruits of the palms indigenous to the tropical islands it inhabited, in the same manner as the latter employs its beak in decorticating smaller fruits and hard-coated seeds.

All that is known of the history of the living Didunculus is soon told. About twenty years since, Lady Harvey bought a collection of Australian birds in Edinburgh. Amongst the skins was one about the size of that of a very large pigeon, of a dark chocolate and resplendent black colour, with the upper jaw or maxilla hooked like that of an owl; the lower jaw or mandible strong, broad, and furnished with three angular teeth at the apex or part that closed under the hook of the maxilla.

Sir W. Jardine described this unique specimen, and figured the head in the *Annals and Magazine of Natural History*, vol. xvi., 1845, and termed it Gnathodon Strigirostris. Being regarded as an Australian bird, it was figured under the same name in Gould's magnificent work on the *Birds of Australia*.

Subsequently the living animal was discovered, by Mr.

* The bird is now placed in the second compartment of the western aviary, which is situated to the right of the main entrance.

Titian Peale, of America, to be a native of the Samoan or Navigator's Islands; and it was named by him the Didunculus Strigirostris, the name by which the bird is now known. Nothing more was learned about this little Dodo until November in last year, when the following letter was received by Dr. Sclater, secretary of the Zoological Society, from Dr. George Bennett, of Sydney:—

"In the early part of June, 1863, a living Didunculus was brought to Sydney by Mr. J. Williams from Apia Upolu, one of the groups of the Navigator's Islands; and on the 15th of June, and the following days, I had several opportunities of examining the bird. At first it seemed rather shy and wild, but afterwards it became more tame, and I could examine it without its manifesting any fear. It is about the size of a Nicobar Pigeon (*Calœnas Nicobarica*), but rather bulkier and rounder in form. Its plumage was not in good condition owing to its having been recently confined in a cage on board ship, but it appeared healthy. This specimen, I should say, was a young bird with immature plumage, and the tooth of the lower mandible not yet developed. When I first examined it the bird showed its fear by occasionally uttering some rapid 'coos' and by fluttering in its cage, but it subsequently became quite tame. It was captured on the Island of Upolu after being wounded in the wing, and was sold by a native to Mr. Williams. It has now been in captivity about nine months, and is kept in a cage which is merely a box with rails in front, like a hencoop. Here it can run on the floor, or sit on a low perch, or conceal itself in the corners, as it is particularly fond of doing, where, with its dark-coloured plumage, it cannot readily be distinguished. When disturbed it would move gently and timidly across the cage, affording an excellent opportunity to the observer of examining it. It is a stupid-looking bird, and has no particular attraction, except the anomalous and extraordinary form of the beak, which cannot fail to excite the attention of the most ordinary spectator.

"The only sound it utters is the quick 'coo-coo-coo,' to which I have already alluded, the beak being always a little open when the notes were emitted. The whole of its plumage is of a chocolate-red colour, deeper in tint on the back, tail, and the primaries and secondaries of the wings; the throat, breast, and wing-coverts being barred with light brown. The upper part of the head was rather bare from the feathers having been rubbed off, but what remained were of a dark slate colour. The base of the beak is orange red, and the rest of the mandibles of a yellowish hue. The tarsi are not feathered, and the legs and feet are of a bright orange red, similar in colour to those of the Kagu. The irides are dark reddish-

brown, and the cere round the eyes is flesh colour. The bird is fed upon boiled rice, yams, and potatoes."

This letter was followed by a second, received by the following mail. In it Dr. Bennett says:—

"I have to add to my account of the bird sent last mail that this bird was captured within five miles of Apia, Island of Upolu; so that the bird is not yet quite extinct in that island, as has been supposed even by the resident missionaries. It is very fond of the mountain plantain, upon which it has often been found feeding in its wild state."

A third letter states:—

"Since my last letter another living specimen of the Didunculus has been brought to Sydney by the Rev. Mr. Rigg, who procured it from a native on the island of Savaii. This I have reason to believe is the identical bird that Mr. Trail, at the instigation of Mr. O'Hea, endeavoured to procure for me, as in reply to Mr. Trail's inquiries respecting the bird, the native informed him it had just been sold to a European on the other side of the island. On the day after the arrival of the vessel, I went on board and saw the bird, which is a much finer specimen than the one in the possession of Mr. Williams. It appears to be full grown, and in adult plumage—the head, neck, breast, and upper parts of the back being of a glossy greenish black; back, wings, tail, and under tail-coverts a deep chocolate-red colour; but I consider that the bird has only recently been changing its plumage, and that the present dark-green feathers will become more brilliant, and the chocolate-red colour of a still brighter hue. The legs and feet are of a bright red colour, and the claws yellowish-white. The mandibles are of an orange-red colour, shading off near the tips to a light yellow. The cere round the eyes is also of a bright orange-red colour; eyes, brownish-black. It is agreed by every one with whom I have conversed, who has resided at the Navigator's Islands, that the Didunculus is nearly extinct, from being eaten by the natives as well as by the cats, rats, and other vermin, and that most of the other ground-pigeons are following its fate from the same causes. The possessor of the last bird says he has never observed the bird to drink water since it has been in his possession. Its food at that time consisted of boiled yams, but it will eat bananas, apples, bread, and boiled potatoes. The lower mandible has the tooth well developed. This bird was very tame, and was eating some boiled yam very voraciously during the time I was inspecting it, bolting down very large pieces.

"This morning I examined both birds; they are evidently moulting, and the younger bird has grown very much since I last saw it, and is becoming now a much larger bird than the

last arrival; from this I am inclined to think they may prove male and female."

Of these two specimens one unfortunately died at Sydney; the other has arrived in safety at the gardens. This specimen is a female; it laid an egg on the voyage. This had been fortunately placed on a shelf, and was rescued from destruction by Mr. Bartlett; the egg is white in colour, and is about the size and form of that of a large variety of domestic pigeon.

The most striking peculiarity in the appearance of the Didunculus is the maxilla and great width of the lower-toothed mandible. This width of lower jaw is characteristic of whole groups of pigeons, and is intimately connected with the manner in which they nourish their young.

Both male and female, as is generally known, take part in the process of incubation. At the time when the young—two in number—are hatched, a peculiar secretion of curdy substance is formed in the crop of the parents. This is disgorged into the mouth of the young, and they are fed solely on this soft food for several days. The young are hatched in a very imperfect condition, and they receive this soft curdy food (which may be appropriately termed "pigeon's milk") by placing the beak nearly up to their eyes in that of the old one, and almost at right angles to it; so that the food disgorged by the parent is received into the expanded spoon-shaped lower mandible of the young. From this mode of feeding the young being universal in the pigeons, all, of necessity, have the expanded mandible, which hence becomes one of the best marked external characters of the group.

That these facts, simple as they are, are not universally known to naturalists, is evidenced by the fact that so good a naturalist as the late Mr. Yarrell, in his valuable treatise on British Birds, describes the old pigeons as feeding their offspring by placing their beaks in the mouths of the young ones.

The loss of the male Didunculus is deeply to be regretted; as, before the final extirpation of the last of the Didinæ, it would have been exceedingly desirable to ascertain the exact circumstances of their incubation and mode of rearing their young. What labour would naturalists of the present day not undergo, in order to see the unwieldy Dodo pumping up its soft food into the jaws of its young (!) Not having the Dodo, however, it behoves us to take the more trouble to ascertain the structure, habits, and food of its living congener, the Didunculus.

RECREATIONS IN NATURAL HISTORY.

CONVERTING science into a recreation is by no means to be despised, as some "budge doctors of the stoic fur" might be disposed to assert; and the foundations of accurate knowledge and profound study have often been laid in the casual attention bestowed for the mere sake of amusement upon some curious or striking natural fact. It is indeed an excellent plan to present the recreational aspects of science first, and leave the inevitable hard work to be encountered after the student has obtained a glimpse of the fascinations that await him when he has passed from the wilderness of ignorance into the promised land of knowledge and truth. Dry treatises adapted to the school or the college might give the requisite start to a small number of determined workers; but the only way to raise up a large body of students of natural science, and to create a general interest in such questions throughout society is to make them a pleasurable exercise, in which large numbers can easily engage. This is the great function of the better class of popular works, in which the elements of experimental or descriptive science are exhibited in an entertaining guise. Some men fancy they must be learned because they are tiresome, and sneer at any knowledge that is not reduced to its most repulsive technical form. They would degrade natural history to an insufferable catalogue of long-tailed names, and try to persuade themselves and the public that the observation of character and habits is unimportant, and that the one thing needful is to acquire the art of arranging objects upon a system, so as to put them into the right pigeon-hole as soon as they are seen. Systems of nomenclature and classification are no doubt indispensable, but they do not constitute science. They are only part of its mechanism, and of no intellectual worth, unless they are associated with clear and positive ideas of structure, development, and modes of life.

Natural history may be approached in a popular and amusing manner in two ways. According to the first, the objects may be viewed in relation to habit and structure; and according to the second, in relation to the use or mischief they do to man. Books of great interest have been written upon both plans, and form no small proportion of the healthy literature which our age provides for family reading. To be successful they demand on the part of their writers considerable acquirements, coupled with the happy art of presenting the salient points of their subject in an intelligible and pleasing light. Mr. Wood has recently added to his labours in the first of these departments a very pleasantly written work, now appear-

ing in monthly parts, entitled *Homes without Hands*, in which the constructive faculties of all kinds of animals are agreeably set forth; and Dr. Phipson has selected an excellent set of subjects under the title of *The Utilization of Minute Life.** If we were disposed to be hypercritical we might say that some of the living creatures whose utility to man forms the theme of Dr. Phipson's essay, are not exactly *minute*, as that term is scarcely applicable to the lobster or the crab; but the general appropriateness of the title will be apparent when we proceed to enumerate the contents. First, we find the Silk-Producing Insects, then the Colour-Producing Insects, then Insects producing Wax, Resin, Honey, and Manna; after which the Insects Employed in Medicine, or as Food, and other Insects useful to Man, are treated in a manner that conveys a great deal of zoological and technological information in a very pleasant way. After the insects Dr. Phipson deals with the Crustacea in one chapter, and with the Mollusca in another; and the work concludes with Worms, Polyps, Infusoria, and Sponges. From this enumeration of subjects it will be apparent that Dr. Phipson has addressed himself to the widest possible range of readers, and by a happy union of chemical, zoological, and technological science, he has provided matter to suit all tastes.

At the present moment two of Dr. Phipson's subjects are especial matters of interest, and to them we shall confine our remarks; first adverting to the efforts for increasing the production of silk, and secondly to the plans in operation for the artificial propagation of mollusca serviceable as food. Attention has been strongly directed to the introduction of new species of silk-producing insects, and to the prevention of the diseases which have proved so ruinous in many silk arms. Amongst the diseases we find "muscardine," caused by a parasitic fungus, for which cleanliness and the removal of sick larva seems the most effective remedy; "atrophy" or "rachitism," "gangrene," "jaundice," "apoplexy," "diarrhœa," "dropsy," for which different methods of treatment are prescribed. "In the department of Vaucluse, where on a small area of land more than two millions of mulberry trees are grown, gangrene resulting from these and other maladies is arrested in its course by sprinkling quicklime over the larvæ by means of a very fine sieve, and then covering them with leaves soaked in wine." The list of complaints sounds shockingly human, and affords a curious, though scarcely pleasing picture, of unity of plan in

* *The Utilization of Minute Life;* being Practical Studies on Insects, Crustacea, Mollusca, Worms, Polyps, Infusoria, and Sponges. By Dr. T. L. Phipson, F.C.S. London. *Groombridge and Sons.*

nature's works. We do not know whether the old-fashioned race of silkworm doctors endeavoured to cure their wriggling patients by cathartics and depletion; but it is interesting to find that in the case just mentioned the system which used to be named antiphlogistic is dispensed with, and alcoholic stimulants exhibited, in conformity with the practice of our best hospital doctors and the interesting theory of Professor Lionel Beale, who would tell us that when the unfortunate silkworm was being reduced to a black fetid liquid through the agency of disease, a little alcohol would moderate the excessive action of the growing material, and restore the balance which health requires.

Dr. Phipson mentions the great success attained by M. André Jean, the director of a large establishment at Neuilly, who has succeeded in introducing a splendid and very large race of silkworms, by breeding exclusively from well-selected specimens.

In addition to the ordinary silkworm the French are occupied in naturalizing other species, especially a fine one from the Himalayas, which lives upon the oak. The Tussah silk is coarser than the silk commonly known in this country, and the worms producing it may probably be reared in European countries to an extent sufficient to exercise an important influence on the ordinary clothing of the people. Dr. Phipson states that "garments of Tussah silk will wear, when in constant use, for ten or twelve years;" and M. Guérin de Menneville has obtained from cocoons of his own rearing "silk so strong, that a single fibre will support without breaking a weight of 198 grains."

A recent number of the INTELLECTUAL OBSERVER contained an account of the employment of spiders to make carpets, and other European insects have been used for their spinning powers. Dr. Phipson has the following remarks upon this subject, and we are enabled to make the quotation more interesting by presenting our readers with one of the numerous excellent engravings with which his book is illustrated:—

"It is a doubtful question whether the breeding of any of the European moths will ever become a source of advantage. Experiments have already been made on certain varieties of clothes moths (*Tinea*). M. Habenstreet, of Munich, experimented some years ago upon a species called *Tinea punctata*, or *Tinea padilla* (Fig. 2), closely allied to *T. Evonomella*. The larvæ of the former were made to spin upon a paper model, suspended from the ceiling of the room. To this model any form or dimensions could be given at will, the motions of the larvæ being regu-

FIG. 2. Tinea padilla (Silk-spinning gnat).

lated by means of oil applied to those parts of it which were not intended to be covered. The investigations showed that on an average two of these larvæ can produce a square inch of silk, and when employed in great numbers their produce is astonishing. M. Habenstreet succeeded thus in manufacturing an air-balloon about four feet in height, one or two shawls, and a complete dress with sleeves, without any seams. The tissue thus curiously produced resembled the lightest gauze, which it surpassed in fineness. We are told that the Queen of Bavaria once wore a robe of this description over her court dress."

Leaving the insect department of Dr. Phipson's work we pass to the chapters on Mollusca, and hope that the repetition in his pages of the accounts of what the French are doing will stimulate exertions to add to the quantity of food produced by our shores. Artificial fish breeding should be supplemented by similar methods of increasing edible mollusks and crustaceans. Nothing can be simpler than M. Coste's plan on the coasts of France. In Dr. Phipson's words, "he gets fresh oysters for propagation from the open sea; he turns to advantage those which are rejected by the trade; and lastly, he collects the myriads of embryo oysters which at each spawning season issue from the valves of the oyster, and which are now lost to commerce for want of some contrivance to prevent their escape and inevitable destruction."

Out of two millions of young produced by a single oyster, only ten or twelve attach themselves to the parent shell, and to save the mass of spawn M. Coste employs a very simple plan, of which we annex a sketch, borrowed from Dr. Phipson's work (Fig. 20). So easy is the artificial cultivation of the oyster

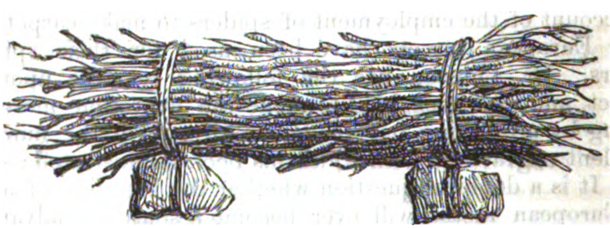


FIG. 20.—BUNDLE OF FAGGOTS FOR PROPAGATING OYSTERS, ACCORDING TO M. COSTE'S SYSTEM.

that "about five-and-twenty thousand acres of coast may be brought into full bearing in three years, at an annual expense not exceeding £400." The young oysters attach themselves to the fascines, and at a suitable age are transported to a zone of the right depth.

Zoologically speaking we ought to have noticed the lobster

and crayfish before the oysters; but in the classification of domestic economy, the latter are the most important. We may, however, mention that both the lobster and the cray-fish may be bred artificially and rendered a cheap article of food. The lobster produces from 15,000 to 20,000 eggs, and the crayfish upwards of 100,000. There is thus plenty of material to work upon, and the principal apparatus is a breeding trough, as shown in Fig. 10, to which we are indebted to Dr. Phipson's work.

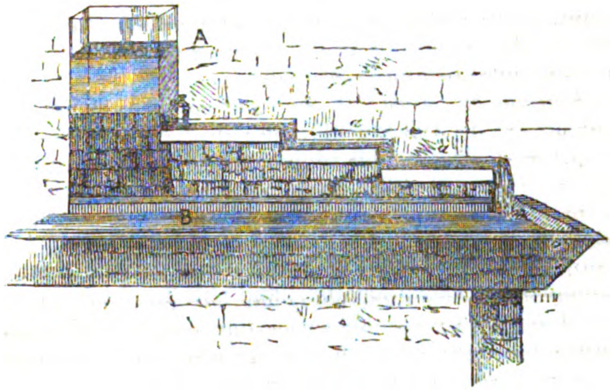


FIG. 10.—BREEDING TROUGHS FOR HATCHING EGGS OF CRUSTACEA, etc. (From a sketch taken at the College de France, Paris.)

A. Cistern. *a. a. a.* Glass troughs, containing gravel: the water flows constantly from one to the other in a gentle stream. B. Large trough for salmon, etc.

We are so convinced that to be generally useful, scientific books must be interesting, that we have given particular prominence to that element in Dr. Phipson's labours, and we are glad to be able to recommend it strongly on that account. We do not, however, wish to convey the impression that, because it is popular, it is not scientific. This is certainly not the case; but the work belongs to the department of Recreational Science, because it relates exclusively to matters that, although not generally known, are interesting and easily understood.

THE FUNCTIONS OF ART.

We do not intend to criticise any individual pictures in the Royal Academy Exhibition or elsewhere. The number of pieces that will receive popular praise or blame will depend chiefly upon the expectations the visitors to the various galleries form concerning the functions of art. If they ask the painter only for clever finger work, they may soon fill up a large laudatory list; but if they demand clever brain work also, they will strike the pen of condemnation through the majority of the names of pieces which they were compelled to praise upon mere technical grounds.

In reading the works of our best modern historians, the graphic power of reproducing and idealizing characters and events gives a charm and value to their pages that we seldom find when we turn from paper to canvas, and expect the pencil to rival or transcend what the pen has accomplished to make us realize the past. If the historian puts together his sentences with technical skill, if his periods are flowing, his grammar unexceptionable, and his meaning plain, we esteem him little, unless he rouses our emotions, excites our sympathies, and gives us some insight into that eternal linking of cause and effect, without which life would be a disjointed and purposeless drama, and the incidents of human story mere rags and tatters of a many-chequered scene. No cleverness of composition makes us merciful to the writer who fails in those higher purposes which composition ought to serve; and why should the man who speaks to us through the mechanism of oils, pigments, and canvas, obtain laudation upon easier terms? If he undertakes to bring before our eyes scenes connected with the assertion of political liberty, or with the insurrection of mind against the conventional forms of dead systems, we ought, before praising his picture, to ask whether, after studying it, we know more of the subject than we did before his labours were exposed to our view, and whether the meaning of the event is more distinctly felt and seen. His anatomy may be unexceptionable, bones and muscles may be in their places; his figures may be well arranged, and their drapery of shape and hue that is pleasing to the gaze; but still, he has failed as an artist, unless the soul and sentiment of the subject glows through every lineament, and gives a moral and intellectual reality to all his work. What is the use of telling an heroic story so as to excite nobody to heroic thoughts or deeds?

Passing from the historic to the domestic, what do the silks and satins, the muslins and the crinolines matter, and what are they worth on canvas more than so much linen-

drapery stock, unless the picture in which they glisten suggests a thought worth having, or an emotion that makes life truer and more beautiful than it was before. Interiors of cottages, village schools, and scenes of amphibious existence on the sea-shore, ought to be something more than works of imitation, tinged with the personal egotism of their manufacturers, before they are entitled to demand our praise. Is there nothing in the peasant life of England but gnarled or chubby faces, fat bacon and hunks of bread? Is there nothing in the interior of our cottage homes—miserable dens though too many of them be—but carrots and crockery, a deal table and a mug of beer? Those who paint peasant life as made up of these beggarly elements, had better leave it alone. You may see the grain of the wood floor, count the knots in the table, feel disposed to pick up the potato peelings, and be a profound believer in the patches on the clothes; but if the painter has seen nothing to idealize, if he excites no sensation of human worth, if his men, women, and children have nothing in them but simple animal characteristics, tinged with want, or degradation, no merit in his brown pitchers or clouted shoes should induce any one to fancy that he has produced a work of art.

Cottage scenes are common enough in our exhibitions; but how few painters perceive the pathetic or the nobler sides of humble life. And yet we know that where the common-place mind can see only its own miserable reflection, there may be enough heroic devotion for a Thermopylæ—enough strength and tenderness for a whole calendar of saints.

We want in art the mind of a poet-thinker, turning everything it touches to living gold; and after an exhibition has been gone through, and the physical fatigue of the process is over, he alone should be dignified by the name of an *artist* who has taught us how to see, or how to feel, or how to think, more truthfully and more beautifully than before. Take aspiration away from art, and it becomes so much dead lumber. If it leaves its votaries with just so much indifference to bad things, and no more love of good things than they previously possessed, it has failed of its purpose; it is like an instrument from which no music can be evoked,—a bell that will not ring, a book that proves to be nothing but leather and wood.

Very often indeed the painter comes forward as the expounder of our great writers, and many works receive high praise upon the merely technical ground that the art-spelling is done properly, when no art-words are put together by which the verse of the poet becomes a stronger and more exquisite reality in our minds. If reading the poem gives us a better picture, the painter has been of no use. We are entitled to ask him to do more for us than our own imagination could easily

body forth. Failing in this, however clever he may have been with his fingers, we do not thank him for his brains.

The artist goes forth at all seasons of the year into the country, and in due course elaborates his landscapes. Here again, after demanding technical correctness, we are entitled to ask for something more. If his canvas looks like the place, and that is all, his human intellect and heart have done little more for us than the photographer's chemicals and lens. If we go to the spot he depicts with no finer associations than we should have had without him; if he has given us small help in seeing, and none in the loftier process of linking together the beautiful and the true; what ought we to care for his work, although its precision might serve to guide the carrier to the right roadside inn, or suggest to maternal solicitude a convenient situation for sea-bathing when the children's holidays arrive.

There is a class of landscape very common in our galleries, and yielding ample profits to its producers. We mean that in which some harsh and discordant effect of blazing light and colour is repeated with certain changes over and over again, and year after year. In another case a man carries his own eternal tameness to every scene—his waterfalls are composed of the same soapsuds, his trees have the same mild stems, and the same pale green leaves; his rocks are smooth enough for the drawing-room table when the cover is off, and his skies simper with one unvaried smile. He is no helper to see or think, not an *artist*, however deftly his brush may glide. Certain other men have discovered an "effect" that will sell, and they produce their effect year after year, just as the crockery maker gives us the everlasting willow plate. In many instances, a certain crotchety egotism and mannerism always comes uppermost. It is evident that artists of this stamp do not look nature honestly in the face. They project one side of themselves upon all they behold. They are not interpreters of nature, nor can be until they have exorcised the demon of self.

Doubtless we have good artists, as well as good brushmen; but tried by their appeal to men's higher faculties, not one picture in a hundred that fetches a high price, and secures the laudation of the common herd of critics, really deserves the name of a work of art. We believe our artists will give more when the public demands more. It is therefore we would stimulate the public demand.

NEIGHBOURHOOD OF THE LUNAR SPOT, *MARE CRISIUM*. JUPITER'S SATELLITES. OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

Our somewhat lengthened examination of the interior of the *Mare Crisium* did not admit of our extending our survey beyond its immediate boundaries. Its vicinity contains, however, some interesting features. The surrounding elevated land is broken up in many places by eruptive force, and some of the craters deserve a passing notice. *Condorcet* (see the diagram in our April number) is a considerable crater, 45 miles in diameter, with a very regular interior, but an exterior quite the reverse, as is frequently the case where such formations occur in mountainous regions. It is about 8900 feet in depth. *Azout* is a similar but smaller crater, 16 miles in diameter; its interior has only 2° of grey light. Four ridges of some height, and nearly equal in length, run from its wall to the "sea," including between them three sloping bowl-shaped valleys. Water-courses, if they were possible upon the moon, might be looked for in such localities, which are not of frequent occurrence. This is the remark of Beer and Mädler, to whom the reader will understand that he is indebted, throughout these papers, for all statements not expressly referred to other authorities. I regret that in this, as in numberless other instances, I can add no corresponding observation of my own; and that with regard to the greater part of the lunar surface I am unqualified to act as guide, excepting upon the information of others. *Firmicus*, more than 38 miles broad, and nearly 5000 feet deep, is connected with *Azout* by a mountain ridge. Like the preceding craters it is of a uniform dark "steel grey," which, under a high illumination, though of the same intensity of light with the *Mare Crisium*, is different in colour, from the intermixture in the latter case of green. *Apollonius*, 30 miles in diameter, is nearly S. of *Firmicus*, and is the furthest in that direction of this crater group. The summit of its S.E. wall is 5400 feet above the interior.

To the W. of this object we come to a more level country, remarkable under high lights for a set of broad, crooked, and branching streaks of dark grey, somewhat resembling, according to B. and M.'s remark, the Saima lakes in Finland. They seem under such circumstances to lie in a perfect plain. Near the terminator, however, they are perceived to be valleys divided by banks of moderate height, and associated with

craters. The aspect of the district is then so changed, that its correct identification as to details requires actual measurement. These great discrepancies, they observe, might easily lead to the idea of casual atmospheric obscurations or other changes; but continuous and persevering observation shows that they are all periodical, and so entirely dependent upon the angle of incident light, that an ephemeris of these phenomena might be constructed to serve for every lunation. Vegetation has been suggested, according to B. and M., by several astronomers, as the cause of these appearances; if so, it would require to be of a nature to run its course in a single lunation. In favour of this idea it might be alleged that many valleys of a precisely similar character are to be met with, especially nearer the Poles, that show no such grey tint, but preserve their bright aspect under high illumination.* All this, however, is little to be depended upon; and it must be admitted that vegetation, in the absence of air and water, is to us incomprehensible. It had already occurred to Schröter that the moon, from the very slight inclination of its equator to its orbit, could possess scarcely any change of seasons; and that therefore the functions dependent with us upon summer and winter, might there be discharged by its lengthened day and night; so that vegetation might be concerned in the change of colour for which some spots are remarkable as contrasted with others, in proportion to the increased angle of the sun's rays. Gruithuisen, as might have been expected from him, pushed the matter much further. He distinguished the grey spots into three classes, each, as he fancied, characterised by a "flora" of its own. 1.—Small levels of a very dark hue, which undergo no change, and may possibly be covered with forests of conifers! 2.—Numberless dark spots which acquire a deeper tone under the advancing light, among which he classes the *Paludes Amaræ* of Hevel, the very region we are now discussing. 3.—The grey plains, which gradually grow darker after sunrise, probably from the dispersion of a low mist. And besides these he noticed traces of another kind of lunar flora, requiring great attention to be perceived, reaching as far as 25° of N. latitude, and gradually creeping up the valleys among the mountains as the sun attains its greatest height. From all this he concludes that there is a lunar vegetation comprised between 65° N. and 55° S. latitude, most luxuriant near the equator, and preserving an analogy between increasing relative height and latitude similar to that which obtains on the earth. Our readers could not be much won-

* It escaped B. and M. that near the Poles the sun's altitude would never be sufficient to admit of a fair comparison.

dered at if they were to consider this "all moonshine," nor would a closer acquaintance with the author increase their confidence in his judgment. But he had a very fine eye, and there may be hints here not to be despised. As to the general question of vegetation, no doubt a flora like our own could not exist under such very adverse conditions. But this would furnish no argument against the possibility of one adapted to its peculiar situation, and we must not omit to mention that one of our first authorities on this point, De la Rue, is inclined to favour such an idea from the circumstance that in the course of his photographic investigations he has found that parts of the moon, equal in apparent brightness, are by no means equal in actinic energy. This indicates the presence, in certain situations, of rays not otherwise manifested, which are incapable of producing a photographic effect—such a result as might naturally be expected if those portions of the surface were clothed with vegetation.

I have been repeatedly struck with the very singular aspect of this region under a high illumination, in its uncommon contour and sharply-defined intermixture of light and darkness; and I venture to think that a very careful study of it might probably be in some way ultimately rewarded. We have not, as far as I am aware, a single representation made on an adequate scale, and with sufficient accuracy, of the appearance of this district in the full moon, and the attempted delineation of B. and M. is scarcely so successful as the rough but characteristic draught given by old Hevelius, of what he calls his "Paludes Amaræ." This is in fact not surprising. The object of Beer and Mädler, as of Lohrmann before them, having been the delineation of the elevations and depressions of the surface, any adequate representation of those varied tones of grey and white, to which the term "local colour" may be conveniently though not very correctly applied, and which are so strangely unconformable with the actual relief, would have been a simple impossibility. Hitherto the attention of selenographers has been, naturally enough, much more directed to the very intelligible relief than to the intricate and perplexing shadowing of the surface; and hence we do not as yet possess either special topographical delineations, or a general map of the full moon, at all corresponding with the present requirements of science.* A general chart would demand a great expenditure of time and labour, especially if the gradations of light are accurately represented, without which it would be of little service; but careful drawings of separate spots might be very advantageously un-

* Russell's, fifteen inches in diameter, published about 1797, is the best that I have seen, but it is rather a spirited sketch than a faithful likeness.

dertaken by amateurs, and would be easily executed with a little skill in outline and shading: their comparison with views of the same objects in the relief of light and shade would be instructive, and they might in process of time acquire considerable importance as records of the present state of a surface, whose markings may perhaps be found not exempt from change. But to return to the *Paludes Amaræ*, or *Neper* a* and its neighbourhood, as this region is styled by B. and M.: grey tracts of a similar character, but perfectly unconnected with these, and less extensive, are to be found at no great distance to the W. of the craters *Hansen* and *Alhazen* of B. and M. (see the diagram of the *Mare Crisium*); another of these streaks lies between the *Alhazen* of Schröter and *Eimmart;* and B. and M. describe several less easily seen in the extreme foreshortening of the limb.

The region between the S. end of the *Mare Crisium* and the equatorial limb of the moon, comprising the craters *Neper* and *Schubert,* has been very unsatisfactorily laid down by B. and M. The result of Mr. Birt's revision of their work will in due time, we trust, be made public: in the mean while, as the requisite correction involves a still larger district lying on the other side of the equator, we shall postpone our notice of it till it comes before us in the Fourth Quadrant.

There is nothing of especial interest to the W. of the *Mare Crisium.* To the N. and NW. we meet with an elevated region, as extensive as Germany, so entirely filled with craters and ring-plains that the intervening mountain ridges are reduced to a position of very inferior importance, and appear to serve principally as means of communication, so to speak, between the more conspicuous features. Several of these latter we shall describe in detail.

Cleomedes (No. 1 in the Index Map) is a fair specimen of the formation which has been at different times styled a Walled, Bulwark, or Ring Plain. This peculiar configuration of the surface differs from the crater chiefly in the level character of its interior, which is frequently little, if at all, depressed beneath the surrounding neighbourhood. It appears to be the type towards which the larger and older craters approximate; but it is difficult to obtain a clear or satisfactory idea of the mode of its original construction, or the stages through which it may have passed. We shall find, however, hereafter still more characteristic and better situated specimens than the one now before us. *Cleomedes* is about seventy-eight miles in diameter, and of a rounded quadrangular form; less dark than the *Mare Crisium,* and not everywhere of a uniform tint. Schröter has noticed that it is deepest beneath the E. wall, a peculiarity

* This letter in the map has more resemblance to a "d."

exhibiting itself, he says, in several other similar great plains, especially *Grimaldi*. The wall is very broad, and falls on each side in terraces—a mode of formation frequently recurring in lunar rings, and worthy of careful attention: it reaches a height on the W. side of about 8700 feet above the interior, rising on the E. side nearly 1000 feet higher, and, dividing in its course, encloses on the NE. a steep depression named *Tralles*, lying no less than 13,700 feet beneath its E. boundary. Several of the neighbouring smaller craters are also, as Schröter has remarked in this and numerous other instances, deeper than the principal cavity with which they appear to be connected. It is a fact especially worthy of attention, that, as this observer has pointed out, when one crater has encroached upon the boundary of another, so as to be obviously of subsequent date, the more recent is almost universally the smaller, as well as the deeper, either absolutely, or at least in proportion to its diameter.

The area of *Cleomedes* contains several small objects. Schröter at first saw three, a low hill in the centre between two loftier objects, of which that to the S. might possibly be a crater, all reflecting an ordinary light of about 4° of intensity. Subsequently, under an angle almost precisely similar, he found the N. spot changed from a longish ridge to a crater of considerable size, and a brilliancy of not less than 7° or 8°, approaching that of *Aristarchus*, the brightest spot on the moon. In another lunation the ordinary-looking hill and its shadow reappeared. On another occasion he saw in this place both the ridge and two craters, the smaller of which had 6° of light, close to it; and subsequently he found the larger crater grey instead of white, and a black shadow in both of them, especially the smaller one, though 6′ 40″ to 7′ removed from the terminator, and though a neighbouring very deep crater (*Bernouilli*) had lost nearly all its shade—thus indicating extraordinary depth and steepness. He had been early persuaded, from many such observations, that "the existence of real accidental workings of nature, not dependent upon the different reflection of light, lies so evidently before our eyes, that if any one would desire a yet stronger conviction, he would do better to give up altogether the closer investigation of the lunar surface, since he (Schröter) did not believe that, with due regard to our shortsightedness, more obvious proofs were possible;" and he thinks it hence certainly demonstrated that these changes are partly atmospheric, depending upon the condensations and clearings up of different seasons, and partly indicative of other unknown agencies working according to the peculiar nature of the surface. In this respect he calls attention to the variations in the colour of the area of *Cleomedes*,

at some times much brighter and more uniform than at others; this, he says, may partly arise from a different angle of reflection, but is probably in part also atmospheric, resembling the periodical changes of weather in some portions of our globe. For, he argues, if reflection alone were concerned, why should the change extend uniformly over the whole breadth of the surface, instead of advancing across it by degrees? and why should not many other similar surfaces be similarly affected? while, on the contrary, as a general rule, the greater spots preserve their colour invariable, whether bright or grey; of which he alleges *Copernicus* and *Plato* as instances, and the large spots in the immediate vicinity of *Cleomedes* itself. He has also called attention to similar variations in the immediate neighbourhood of *Cleomedes*, especially between it and the *Mare Crisium*, where black shadows and grey patches among the mountains exhibited to him a strange inconstancy of aspect, even under similar angles of incidence and reflection of light. As to all this, Beer and Mädler would be at issue with their predecessor, and would resolve the whole affair into the effects of varied illumination. It is very probable that there may have been more in this than Schröter has allowed for; and as the question affects the labours of future selenographers, and may prove perplexing to the uninitiated student, it may be well to give some attention to it in this place.

That apparent change of position in the lunar spots which is termed Libration, arises, as is well known, from two independent causes, and the whole effect is a combination of the results of each. Libration in longitude—which causes sometimes more of the E., sometimes more of the W., limb to come into sight, and throws the mean apparent centre of the moon at one time into the E., at another into the W. hemisphere—arises from the unequable velocity of the moon in its elliptic orbit, combined with its equable rotation on its axis, whence any given point on its surface will sometimes appear in advance of, sometimes behind, its mean position. This will, of course, alter the perspective projection of all objects in an E. and W. direction, affecting the equator most strongly, the poles not at all; while, as regards the direction of the incident solar light, and the corresponding amount of shadow, the result will be the same as if the globe of the moon were swung slightly round its axis, backwards or forwards, as the case may be, alternately on each side of its normal or mean position. The *real* length of the shadow will thus be a little varied, by turning the object somewhat to or from the sun, and its *projected* (or apparent) length, by turning it somewhat to or from the eye; the former effect being greatest in the centre, and least near the limb, the latter greater at a distance of 45° from the centre than in either of those two positions. The extreme

amount of this libration in longitude may be 7° 55′ each way. The other kind of libration, that in latitude, is of a less simple nature, and its effect is not so readily allowed for. It arises from the fact, that the plane of the moon's equator is coincident neither with that of the earth's orbit nor its own. Were all these identical, the moon's equator would always pass as an imaginary straight line across the centre of the disc, and the poles would stand exactly in the limb. But, as the moon's orbit is inclined to the ecliptic at a mean 5° 8′ 49″, the lunar globe is carried, during each revolution, alternately above and below the level of the eye; and hence the equator is sensibly straight only when the moon is in its node or passage across the ecliptic. At all other times it is projected, either upwards or downwards, into a narrow semi-ellipse of continually-varying dimensions corresponding with the moon's latitude, and each polar region in turn comes more into sight, or passes away into the invisible hemisphere. Such would have been the case from the inclination of the orbit, even had the plane of the moon's equator been coincident with, or parallel to, that of the ecliptic; but, in addition to this, it is inclined to it at an angle of 1° 28′ 47″; so that the whole change in projection, in a N. and S. direction, may amount at a maximum 6° 47′ on either side of the mean position. This has, of course, the same effect as the libration in longitude, in proportion to its amount, on the perspective foreshortening of the surface, though not, like that, in an E. and W., but in a N. and S. direction. On the contrary, it has no influence on the *actual* length of the shadows; though, from its allowing us to see sometimes more, sometimes less, of the foreshortened interior of a crater or base of a mountain, there may be a little change in their *visible* extent. It has, however, an effect of some importance on the *direction* in which the shadows fall. We have been referring only to the angle under which we view the surface—in other words, the angle of reflected light; but the angle of incident light has also to be considered, since it also varies, though to a less degree. The deviation of the moon on either side of the ecliptic, is, in this case, less important, the 380-fold distance of the sun rendering its angular amount there so much less than it subtends at the earth; but the inclination of the lunar equator to the ecliptic, as seen from the sun, produces the full effect of its angular value; and the moon's axis being tilted at one time towards, at another from the sun, the direction of the incident light will be varied in the same way, though by no means in so great a degree, as in the different seasons upon the earth; the sun will not rise and set at precisely the same points of the lunar horizon, or attain exactly the same meridian altitude; and hence, the appearance of objects may be much varied, especially of such as lie nearly in

an E. and W. direction. For instance, the face of a cliff may, from this cause, in one lunation be visible in feeble illumination; in another, at the same age of the moon, it may be entirely darkened itself, and even cast a perceptible line of shade. Gruithuisen pointed out the effect thus produced on the dimensions of the shadow of the lunar *Apennines*, but it seems not to have been duly allowed for by Schröter.

While the direction both of incident and reflected light is thus continually changing from the combined effect of the two librations, it is easy to see how optical illusions may be of continual occurrence, and how objects whose diversified planes and angles render their aspect peculiarly dependent upon the mode of illumination, may often exhibit themselves in a strangely altered guise; and the fact that even the *maxima* and *minima* of libration are subject to some amount of change, although slight, from the peculiarly variable character of the lunar orbit, introduces still greater difficulty into the attempt to eliminate, from observed appearances, this fruitful source of uncertainty and deception.

The student will, it is hoped, regard with indulgence this disquisition, which has extended itself far beyond the original intention, and which goes in part over ground traversed upon a former occasion. To some readers it may appear very uninteresting. But, as far as I have observed, the differing character and combined result of the two librations have not been fully and distinctly elucidated in the ordinary treatises on elementary astronomy, though it is of especial importance that the subject should be clearly understood by the selenographical student: in no other way can he form a just notion, from his own observations, of the probability of actual change in progress on the lunar surface, or of its being subject to atmospheric obscuration; and in no other way could we expect to bring to any satisfactory conclusion a comparison of the labours of our predecessors. In the present, as in many another instance, B. and M. challenge the supposed variations of Schröter. On the grounds just assigned, implied rather than distinctly explained by them, their position may be defended, that the alleged changes may be accounted for without the supposition of physical alteration. On the other hand, in behalf of Schröter's idea, his own argument may be adduced, that such merely optical effects must be confined within narrow limits, or the whole surface would appear to be in a state of fluctuation and uncertainty, and changes would supervene in the course of a few hours' observation; experience showing, on the contrary, a great and general uniformity, which renders the occasional exceptions the more remarkable: to which may be added that all such variations must be periodical, and would

ultimately compensate themselves under the eye of a patient observer:—the epoch of mean libration returning almost exactly at the end of every three years. So that at present the decision of this curious question may perhaps be considered as in abeyance: if we are forced to conclude that Schröter was often mistaken from not sufficiently adverting to the effects of libration, or from his imperfect mode of measuring it, we may ourselves occasionally err on the other side, and only impede fair and full investigation, by ascribing everything which we do not know how to account for to this cause alone.

To return in conclusion to *Cleomedes*, the original source of all this discussion. The objects in the interior specified by B. and M. are, a central hill, 6° bright in the full moon, but not very distinguishable under oblique illumination: it is not evident whether this is the same with the hill described by Schröter, or whether what he saw was a part of the ring of a small crater (B in the map of B. and M.), a little S. of it: three deep craters equally luminous in the darker S. part, of which the map shows but two, that furthest S. lying, where Schröter once perceived it, at the foot of the wall:—and in the N. part three somewhat larger, that in the W. 8° bright and very conspicuous, but, as even these advocates of unchangeableness are obliged to admit, not always equally defined, in the full moon.

Gruithuisen tells us that, 1825, April 6, he saw distinctly in the W. part of the interior of *Cleomedes* elevations resembling long straight hills, including several rhombus-shaped spaces between them. These rapidly became invisible, and he thought the appearance indicative of something artificial, perhaps connected with cultivation. His figure, as engraved by Bode, represents between the W. wall and the central hill, which is double and casts a long shadow across half the plain to the WSW. (thus showing the libration at the time), an object of considerable size, like a lozenge in heraldry; in fact, a foreshortened square lying obliquely, subdivided into four similar spaces by a cross-bar each way. But Gruithuisen himself condemns it as an unsuccessful representation.

In an old sketch of my own, 1849, April 26, the central hill is also represented as distinctly double; and there are two craters to the N. as in Schröter, the larger one having, as he has described it, a small elevation in the midst of its grey interior. I have not yet examined *Cleomedes* with my present instrument.

On a mountain plateau, a little to the left of this great ring, B. and M. describe a crater between four and five miles across, on whose wall another of one-third its diameter has encroached. This latter is worthy of notice, as being apparently deeper than it is broad.

TRANSITS OF JUPITER'S SATELLITES.

June 6th. Shadow of II. departs, 10h. 13m. 7th. I. enters, 12h. 20m.; its shadow, 12h. 56m. 9th. Shadow of II. goes off, 9h. 37m. 13th. Shadow of II. enters, 10h. 27m.; II. goes off, 11h. 20m. 16th. I. departs, 10h. 45m.; its shadow, 11h. 31m. Shadow of III., 11h. 33m. (an interesting conjuncture; the two shadows will appear on the disc together, that of III. being distinguishable by its larger size and slower motion, and they will pass off nearly at the same time). 20th. II. enters, 11h. 20m. 23rd. III. enters, 9h. 49m.; I. follows, 10h. 21m.; shadow of I., 11h. 14m.; III. goes off, 11h. 52m.; its shadow not entering till 13h. 22m.

OCCULTATIONS.

June 11th. p^3 Leonis, 6 mag., 10h. 38m. to 11h. 37m. 17th. ω^1 Scorpii, 4½ mag., 12h. 27m. to 13h. 34m.

ON THE HERRING.

BY W. NEWTON MACCARTNEY, COR. SEC. G. N. S.

The history of the *Clupea harengus* is but imperfectly known, our information comprising only a few more easily observed facts, while those habits which would assist us in the preservation and cultivation of the herring-fishery have as yet escaped our notice. What has been discovered is only the foundation for future efforts, which, if conducted systematically, cannot fail to produce valuable results. While our information concerning some of the lower forms of life is so complete, it is to be regretted that our knowledge of the herring is so meagre, for we lay ourselves open to the *cui bono* of the utilitarian, who, ever ready to pounce upon the naturalist, demands why we spend time unravelling the generation of the medusæ, the animality of the zoophytes, and other questions, to the neglect of those which, like the habits of the herring, have a greater interest, and are of more economic value. As yet, it must be confessed, deep mystery hangs over such questions as the age, season of spawning, and many other habits of the herring, which, for the public good, should be cleared up and set at rest, for measures taken in ignorance may result in the extermination of a most important and valuable fishery.

The herring is placed among the Physostomes, with the salmon, cod, eel, and other fishes, because the air-bladder and stomach are joined by means of an air-tube passing from the one to the other. It belongs to the order of Malacopterous fishes, which have their fins supported by flexible and branched

jointed rays, and are possessed of comb-like gills, with very large gill orifices. The most important family in this order is the Clupeoid, embracing the herring, sprat, whitebait, pilchard, and anchovy, with many more fishes, largely made use of for food.

The herring is exclusively an old-world fish, being confined to the coasts of Britain and Europe, but never found on those of America. It congregates in large shoals, swimming near the surface of the water, and, because of its numbers, has received the specific name of *harengus*, which, according to Artidi, is the latinized form of the German word "häring"—a host. From observations made on its growth, we are disposed to believe that it is found in four conditions; or, in other words, it has four names for its various stages of growth. The fry, which are small, minute fish newly escaped from the egg, retain this name till they reach the second stage, when they measure from five to six inches in length, and are then called maties. While maties, there is a large deposition of fat surrounding the alimentary canal, which is stored up for the use of the individual during the breeding season. While in the matie form, the reproductive organs are but slightly developed, but as they become full herrings, which is the name for the third change, the stored fat becomes absorbed, and by some is thought to assist in the development of the ova, which, in the full herring, attains its fullest growth, and is then shed or deposited.

After the performance of this function, the fish is sickly and weak, and is then called a shotten or spent fish. These four, the fry, matie, full, and spent, comprise the changes which the herring undergoes from its escape from the egg till its performance of the reproductive function. While passing through these changes, it moves from deep to shallow water, according to the season of the year and the requirements of nature. The older writers believed that the herring was only a visitant to our shores, coming in great "sculls," or shoals, from the Arctic seas to spawn upon our shallows, and after circumnavigating our islands, journeying back to their icy houses in the northern ocean. Pennant, unable to account for them after they left the spawning-beds, considered they must have returned to the Arctic seas, "in order to recruit themselves after the fatigue of spawning." He never took into account the exertion and labour of a journey due north, nor the difficulty of getting sufficient food in the ice-bound seas around Spitzbergen. We have the testimony of Arctic explorers that the herring is comparatively rare in the north; and, above all, we know that they never leave our seas, but remain in deep water not far from the spawning-beds.

The fry, after leaving the egg, move about on the shallow

spawning-ground till they attain a few inches in size, and then they take to the deep water near the shore, where they find abundance of small crustacea and animalculæ on which they feed and become fat maties. They then change into full herrings, and leave the deep sea, approaching the shore where it is suitable for spawning, and there, in great numbers, one shoal above another, extending for many miles, they begin to shed the spawn, which falls to the bottom, and, being of a sticky nature, clings to the stones, and there remains, unless disturbed by storms or trawls, till the young fry burst the egg. The spent fish then leave the shallow water, and seek rest and food in the deep waters far beyond the reach of the net.

How long the herring takes in passing through these changes, and becoming an adult fish, is not known. Some think two, and others as many as seven years are required.

We are not disposed, for various reasons, to agree with these observers, for we consider that all the time required is not more than one year. When we consider that each shoal of fish affects a certain specified part of the sea, never spawning except on the "family ground," we cannot account for the plenty of one year and the scarcity of the next, except by the theory that they pass from the ova to the adult in one year. If we compare the ages and changes of a herring with those of a salmon, we think that the following estimate of the herring's age will be tolerably exact:—two weeks for the production of the fry from the egg, three months to become a matie, four months to feed and fatten into a full fish, and two months to develope the ova and to shed it, thus making ten months from leaving the egg till it becomes a shotten herring ready to retire into deep water, there to become again a full herring, and thus for years returning to spawn, if it is lucky enough to escape the enemies which are always ready to devour and destroy it.

The enemies of the herring are legion. Codfish, hakes, eels, and porpoises pursue it beneath the waves. Razorbills, gannets, and gulls watch its progress from above, and man, provided with implements, does his utmost to capture and destroy it. Such havoc is made by the fish among the spawn and fry that only one fish in every six thousand eggs comes to maturity; yet, with such a waste, the numbers remain as great as ever, for each full fish deposits about seventy thousand eggs; so that there is every probability, if the fishing is rightly conducted, of plenty continuing to all time.

The fish are said to be sometimes erratic in their tastes, affecting one spawning ground for many years, and then forsaking it. Pennant considered they became dissatisfied with the beds, and thus left them, but the true reason is the illegal

and suicidal means which have been used for their capture, resulting in overfishing of the herring and the destruction of the spawn. When trawling is practised, great damage is done to the spawn, and the net being drawn through a "scull," or shoal of the fish, breaks what is called the "eye" of the fish, or, in other words, scatters the shoal, and frightens them from their usual haunts.

Pennant was wrong in supposing that the one shoal of herring visited various spawning-beds, for every fish-curer knows well that the fish frequenting one loch or bay is different from those spawning ten miles distant. In fact, the fish can be distinguished as Lochfynes or Stornoways with perfect ease, thus proving beyond doubt that they have but a local range, and return to spawn on the same shallows they formerly frequented.

These spawning-beds are well known to the fishers, who often use illegal means to compass the capture of the spawning fish by employing trawl-nets, which, dragged over the mass of spawning and gravid fish, tears up the spawn and entangles great quantities of the fish.

The spawn torn from the bottom is driven by the tide ashore, and, consequently, rendered useless. The trawl compasses the capture of the sickly, weak, and unhealthy fish, and renders them unfit for preservation.

Trawling is made illegal on the west coast of Scotland, yet there are many who risk their property in the pursuit; and as there is both excitement and profit in the work, all the efforts as yet made have been unsuccessful in putting an end to it. The peculiar mode of fishing adopted by the trawlers is as follows:—A net, about one hundred yards in length, with meshes of three-quarters of an inch in size, is supplied with corks on one edge and heavy weights on the other, and this is attached by the extreme ends to two boats, one of which remains stationary over the spawning-bed, while the other describes a circle round it, returning close to the side of its consort. By this act, the net which has sunk to the bottom is dragged round myriads of the spawning fish and enclosed. The net is now raised to the surface, and the fish taken on board, when, with sail and oar, the boat makes for the harbour, there to dispose of the ill-gotten gains for a good round sum, because the first of the market is gained, as the drift-net fishers are not able to get into port till on in the day.

When the trawlers come ashore, large quantities of spawn is found in the boat, and, according to good authority, many tons are cast ashore after the trawl has been in operation. Couch bears testimony to the destruction caused by the trawl, and fears for the ultimate value of our fisheries.

To understand the drift-net fishing, we will, as the night

approaches, slip on board a fishing craft, and spend a night at the sea. As the sun sinks beneath the western hills we leave the shore, our sails are unfurled, and our boat dashes out to sea. The fishers watch for signs of the herring, which are easily noticed, for yonder the gulls and gannets are in plenty, wheeling in the air, and then dashing into the sea, emerging with a *clupea* for supper. The herring are there in plenty, and to that place our course is shaped. As we approach, a faint phosphorescence is noticeable on the waters, caused by the presence of the herring "scull." Here, then, we begin to shoot our nets, which are in lengths of 800 to 2000 yards, having meshes of one inch. The net, as it is passed over the stern of the boat, has small corks along the upper edge, with here and there large bladders, which keep it above the surface, while the lower and under part sinks to a depth of eight yards. When all the net is out, the boat is allowed to drift, with the net attached. When morning breaks the net is hauled in, the fish unmeshed, and then the boat is turned harbourwards, with her cheeping cargo—for the fish emit a sound similar to that—and we arrive just as the sun rises above the eastern hills, gilding with glory the rippling waves. The drift-net allows the fish to entangle themselves—no force is used, and the shoals of fish are not disturbed, for, while the fish are moving about during the night they come against the meshes, and in their efforts to pass on get caught by the gill covers, and are captured. The herring caught in the drift-net are all healthy, lively herring, because only these swim near the surface. They are, therefore, "halesome faring," while those taken by the trawl are unfit for human food.

Herring can be caught by means of bait, and they often rise to an artificial fly; but the formation of their gills, and the tenderness of their mouth, renders their capture difficult.

We have made mention of the fish leaving some spawning-beds, and staying away for many seasons. The fisher thinks they are scared by noise; and in Scotland, in olden times, no cannon was allowed to be fired during the time of spawning. It is said that the herring forsook the Baltic after the battle of Copenhagen, and are only now returning to their former haunts.

Lately an outcry arose against burning kelp and running steamboats, as the smoke of the one and the noise of the other scared the fish away; but the most wonderful reason given for their disappearance is that mentioned by a Member of Parliament, in 1835, before the House of Commons. He said that the herring had deserted the coasts near the residence of a priest who had signified his intention of taking tithes of fish.

In concluding this brief sketch of the herring and its

history, we cannot forget to draw attention to the recent inquiry made by the Royal Commissioners. Much valuable information has been gained by it concerning this important fishery; and it is to be hoped that the exposure of our ignorance will result in some experiments being made to discover the true answers to such questions as those we have mooted in this paper.

We think that a series of experiments similar to those made upon the salmon would be of great use. We are aware of some who are willing to aid, both with time and money, in conducting such experiments; and, in our opinion, till such is done, the herring will be as great a mystery as the salmon was.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from page 221, vol. v.*)

840 [ii.] On December 3 a comet was seen in the E. country.—(Ma-tuoan-lin.)

841 [i.] Before the battle of Fontenay (that is, before June 25), a comet was seen in Sagittarius.—(*Annal. Fuld.*) In July or August a comet was seen near χ Aquarii.—(Ma-tuoan-lin.)

841 [ii.] On December 22 a comet was seen near α Piscis Australis; it passed through Pegasus into the circle of perpetual apparition. On February 9, 842, it had disappeared.—(Gaubil.) It was seen in the W. from January 7 till February 13.—(*Chron. Turon.*)

852. In March—April a comet appeared in Orion.—(Ma-tuoan-lin.)

855. A comet was seen in France for three weeks.—(*Chronicon S. Maxentii.*) Perhaps in the month of August.

857. On September 22 a comet with a tail 3° long was seen in Scorpio.—(Ma-tuoan-lin.)

858. At the time of the death of Pope Benedict III. a comet appeared in the E.; its tail was turned towards the W.—(Ptolemæus Lucensis, *Historia Ecclesiastica,* xvi. 9.) Benedict died on April 8.

864. On May 1 a comet was seen.—(*Chronicon Floriacense.*) On June 21 a comet was seen to come from the E. It was near α and β Arietis, and had a tail 3° long.—(Ma-tuoan-lin.)

866. Comets were seen before the death of Bardas.—(Con-

stantinus Porphyrogennetus, *Incerti Continuatoris*, iv.) Bardas was killed on April 21.

868. About January 29 a comet was seen for seventeen days. It was under the tail of the Little Bear, and advanced to Triangulum.—(*Annal. Fuld.*) It was seen in China in the sidereal divisions of γ Arietis and α Muscæ.—(Ma-tuoan-lin.)

869. A comet announced the death of Lotharius the Younger.—(Pontanus, *Historia Gelrica*, v.) Lotharius died on August 8. In September a comet was observed near χ, κ, θ, τ, Persei. It went to the N.E.—(Ma-tuoan-lin.)

873. A comet was seen in France for twenty-five days.—(*Chronicon Andegavense.*)

875. The death of the Emperor Louis II. was announced by a burning star like a torch, which showed itself on June 7 in the N. It was seen from June 6 in the N.E. at the first hour of the night. It was more brilliant than comets usually are, and had a fine tail. This bright comet, with its long tail, was seen morning and evening during the whole of June.—(*Breve Chronicon Andreæ.*) After harmonizing some discrepancies of dates, Pingré says, "The comet would have appeared on June 3 in Aries; having but little latitude, it would consequently have risen a little after midnight, and would have been seen that same night. The following days, as its longitude diminished, and its north latitude increased, it would have been seen by June 6 or June 7, in the evening, towards the N.E.—(*Comèt.* i. 349.)

877. "In the second year of the entrance of Charles the Bald into Italy a comet was seen in the month of March in the W. and in the constellation Libra. It lasted for fifteen days, but was less bright than the preceding one [that of 875]. In the same year the Emperor Charles died."—(*Chronicon Novaliciense.*) Being in Libra, it was in opposition to the Sun, and was therefore visible all night; in the evening in the E. and in the morning in the W.—(Pingrè *Comèt.* i. 350.) Ma-tuoan-lin says that it appeared in the fifth Moon, or in June—July.

882. On January 18, at the first hour of the night, a comet with a prodigiously long tail was seen.—(*Annal. Fuld.*)

885. A comet was seen between a or π Persei and κ Geminorum.—(Ma-tuoan-lin.)

886. On June 13 a comet was seen in the sidereal divisions of μ^2 Scorpii and γ Sagittarii. It traversed Ursa Major and Boötis, near o and π.—(Ma-tuoan-lin.)

891. On May 12 a comet with a tail 100° long appeared near the feet of Ursa Major; it went towards the E. It passed by a Boötis, and went into the vicinity of β Leonis. On July 5 it had disappeared.—(Ma-tuoan-lin; J. Asserius. *Annales.*)

892 [i.] A comet appeared this year in the tail of Scorpio. It lasted four weeks, and was followed by an extreme drought in April and May.—(*Chron. Andegav.*) In June a comet with a tail 2° long appeared.—(Ma-tuoan-lin.)

892 [ii.] In November—December a comet appeared in the sidereal divisions of ϕ Sagittarii and β Capricorni.—(Ma-tuoan-lin.)

892. [iii.] On December 28 a comet appeared in the S.W. On December 31, the sky being cloudy, it was not seen.—(Ma-tuoan-lin.) This may be identical with the preceding.

893. After several months of very bad weather, the clouds went away, and on May 6 a comet was seen near ι and κ Ursæ Majoris, with a tail 100° long. It went towards the E., entered the region lying around β Leonis, and traversed Boötis near Arcturus, passing the region around α Herculis. It was visible for six weeks, and its length gradually increased to 200°. The clouds then hid it.—(Ma-tuoan-lin.) The length is incredible, though Gaubil gives the same.

894. In February—March a comet was seen in Gemini.—(Ma-tuoan-lin.)

LITERARY NOTICES.

On the Structure of the so-called Apolar, Unipolar, and Tripolar Nerve Cells of the Frog. By Lionel S. Beale, F.R.S. etc., etc. *Trans. Royal Soc.*, xxvi.

On Deficiency of Vital Power in Disease. By Lionel S. Beale, M.D., F.R.S., etc. (Richards).

First Principles. *Ibid.*

Archives of Medicine, Edited by Lionel S. Beale, vol. iv. (Churchill).

The first of these publications would alone secure for Dr. Beale a foremost place amongst physiological microscopists. The plates are beautiful illustrations of a series of investigations truly wonderful for the care and skill with which they have been carried out. They are as much an honour to the microscopical science of our country, as they are proofs of the highest order of talent for this class of research. We made a slight mention of this paper in our number for Sept. 1863, p. 148, and we now present the reader with a summary of the most important of its author's conclusions:—

"1. That in all cases nerve cells are connected with nerve fibres, and that a cell probably influences only the fibres with which it is structurally continuous. 2. That *apolar* and *unipolar* nerve cells do not exist; but that all nerve cells have at least two fibres in connection with them. 3. That in certain ganglia of the frog there are large pear-shaped nerve cells, from the lower part of which two fibres proved a *straight fibre* continuous with the central part of the

body of the cell, and a *fibre* or *fibres* continuous with the circumferential part of the cell, which is coiled *spirally* round the straight fibre. 4. These two fibres often lying very near to, and in some cases, when the spiral is very lax, nearly parallel with each other, at length pass towards the periphery in opposite directions. 5. Ganglion cells exhibit different characters, according to their age. In the youngest cells neither of the fibres exhibit a spiral arrangement: in fully formed cells there is a considerable extent of spiral fibre; but in old cells the number of coils is much greater. 6. These ganglion cells may be formed in three ways, *a*, from a granular mass, like that which forms the early condition of all structures; *b*, by the division or splitting up of a mass like a single ganglion cell, but before the mass has assumed the complete and perfect form; *c*, by changes occurring in what appears to be the nucleus of a nerve fibre . . . . 8. There are nuclei in the body of the cell. . . . . 9. The matter of which the nucleus is composed has been termed by me *germinal matter*. From it alone growth takes place. . . . . 10. The nucleolus consists of germinal matter. . . . . 15. As nerve fibres grow old, the soluble matters are absorbed, leaving a fibrous material which is known as connective tissue, and corresponding change is observed in other textures both in health and disease."

We are very glad that the two lectures called "First Principles," and "On Deficiency of Vital Power," have been published in a cheap pamphlet form, because, whatever doubt may attach to certain portions of Dr. Beale's speculations, the facts which he adduces and very much of his reasoning appear to us essential to the right understanding of many highly important problems. Instead of vaguely telling his pupils that irritation excites inflammation, he shows that in a normal state what he terms "germinal matter," in living cells, receives and converts a regulated portion of nutriment from without. By softening the layer of what he terms "formed material," which surrounds the germinal matter, or by tearing through the formed material, an abnormal quantity of pabulum is introduced, and an excessive action of the germinal matter takes place that is not consistent with the health of the organism of which the cells form a part. "The abnormal pus corpuscle is produced from the germinal or living matter of a normal epithetial cell, in consequence of the germinal matter of this cell being supplied with pabulum much more freely than in the normal state."

In the other lecture Dr. Beale lays down the proposition that all living particles have sprung from pre-existing living matter. It cannot be said that we *know* this; but it may be true. "Each separate particle increases, not by particles already existing being applied to it, or coalescing with it, but by the passage of soluble matters into its very substance, and their conversion into matter of the same kind." Arguing logically from the premisses we have extracted, Dr. Beale contends that pus cells, cancer cells, and so forth, exhibit a high, and not a low degree of vital activity.

Disease often differs from health only in the too great activity

with which certain functions are performed, and he shows that alcohol, by hardening the outside layer of cells, diminishes the supply of nutriment that reaches the germinal matter, and thus checks the excess of action that is doing harm.

Having assailed the sham explanations of ordinary physiologists about "diminution of vital force," "irritation," etc., it is curious to find Dr. Beale reverting to the style of argument in which the purgative action of jalap was "explained," by asserting that the drug possessed a "cathartic principle;" and yet this is done in a paper that will be found in the *Archives of Medicine*. Dr. Beale says, "It seems to me probable that the most minute living particle which it is possible to conceive, is a spherule, and this spherule is capable of altering its form. I believe that the alteration results from the influence of wonderful inferent powers, of the nature of which we know nothing as yet, which wonderful powers may at least for the present be termed 'vital,' to distinguish them from physical and chemical properties." In another passage Dr. Beale says, "I have endeavoured to show that the power of movement resides in the living particles themselves, and have expressed the opinion that these movements cannot be explained by physics or chemistry." In another paper the whole fabric of modern science, with its conservation and correlation of forces, is assailed to make way for the return of the old metaphysical assumption, "vital force," which Dr. Beale affirms to be something quite distinct from chemical or physical force in any form. He complains that "vital power no longer excites the speculation of the physiologist or the wonder of the profound metaphysician;" but if it has ceased to do, it is simply because men have discovered that "vital force" is a phrase to cover ignorance, not a term denoting a precise thing. There is no *special* mystery in vital force, if it designates the power that is manifested in living beings. All force is equally mysterious. Scientifically we know nothing of the primary cause, origin, or action of any force whatever. We know that a certain force *is*, and we find out a few of its relations of antecedence or consequence, and when we come to the highest actions we know of, those of mind and consciousness, we have not the faintest idea *why* or *how* the Divine Being has linked them, in our case, with what are called vital actions of an organism.

When Dr. Beale states that living particles must possess an "inherent moving power," we do not know what he means. Would they move under any conditions, and in any medium, as they do under particular conditions, and in a particular medium? If not, they are under the influence of surrounding circumstances, and their motions would appear to be, not an inherent faculty, but the result of their acting, and being acted upon, by matter external to themselves. Nothing is gained by assuming that they are governed by vital forces, "of the nature of which we know nothing," to the exclusion of all the forces of which—so far as their manifestations go—we know a little. It is because we admire Dr. Beale's great talent, and appreciate his services, that we urge him not to tumble into the old quagmire of substituting imaginary metaphy-

sical entities like "vital force," for more scientific methods of explaining what he sees, or for what is often required, a simple confession that the explanation is unknown.

LESSONS ON ELEMENTARY BOTANY. By DANIEL OLIVER, F.R.S., F.L.S., Keeper of the Herbarium of the Royal Gardens, Kew, and Professor of Botany in University College, London (Macmillan and Co.).—In noticing the Memoirs of Professor Henslow in a former number, we adverted to his success as a botanical teacher of village children as well as of his Cambridge class. The present work is partly original, and partly founded upon the papers left by Professor Henslow, and it appears to us an invaluable introduction to the study of botanical science. It is very clearly written, and amply illustrated, leading the student on by an admirable method. As the object is to teach botany as a science, and not as a mere art of giving nicknames to vegetables, it will be highly appreciated by the possessors of microscopes, who will learn from it what they are to look for in accessible plants. It cannot be too strongly recommended to students and intelligent families.

A SERIES OF SEVEN ESSAYS ON UNIVERSAL SCIENCE. By THOMAS CLARK WESTFIELD, F.S.A. (Hardwicke.)—The publication of this book is a mistake. The author should not have attempted a subject so far beyond his powers.

SAXBY'S WEATHER SYSTEM, OR LUNAR INFLUENCE ON THE WEATHER. By J. M. SAXBY, Esq., R.N. Second Edition (Longmans). —Captain Saxby's main dictum is, "That the moon never seems to cross the earth's equator without there occurring at the same time a palpable and unmistakeable change in the weather. Such changes most commonly are accompanied either by strong winds, gales, sudden frost, sudden thaw, sudden calms, or other certain interruptions of the weather, according to the season." The present volume contains many illustrations which the author considers to prove the truth of this principle, and concludes with numerous predictions for 1864 and 1865.

HOMES WITHOUT HANDS. By the Rev. J. G. WOOD, M.A., F.L.S. (Longmans).—An interesting family work, published in monthly parts, with numerous and excellent illustrations. It is a good idea to give a popular and entertaining account of the various members of the animal kingdom remarkable for constructing "Homes without Hands," and Mr. Wood's pleasant labours are sure to be welcome in thousands of homes constructed with hands.

LECTURE ON THE SOURCES OF THE NILE. By CHARLES T. BEKE, Esq., Phil. D., F.S.A., Manager of London Institution.—This lecture was first delivered at the London Institution on the 20th January, 1864, and has since been repeated elsewhere, but not formally published, though printed by the London Institution Board of Management. Dr. Beke affirms that "Captains Speke and Grant have returned from visiting three sides of Lake Nyanza, leaving wholly unexplored a blank space of 50,000 geographical square miles (larger in extent than the whole of England and Wales) on the

fourth and uphill side of the lake, where the sources of the river have naturally to be looked for."

THE CLASSIFICATION OF THE SCIENCES; to which are added REASONS FOR DISSENTING FROM THE PHILOSOPHY OF M. COMTE. By HERBERT SPENCER, Author of "First Principles," "Social Statics," etc. *Williams and Norgate.*

We cannot divert from our ordinary subjects enough space to do justice to Mr. Spencer's important essay, in which he points out where his philosophy differs from that of Comte, to whom we think he is scarcely just. M. Comte made a serious mistake in attempting to construct a system in which an intelligent First Cause had no place; and when he tried to imagine a kind of theology that would supply the defect, he resorted to speculations of the most unsatisfactory kind. We believe, however, that he has exercised a very beneficial influence over modern thought through the truth and utility of many of his ideas. His classification of the sciences was certainly imperfect; but this was partly occasioned by the fact that there are really no palpable lines of demarcation, one science merging into another at several points. Mr. Spencer's labours supply valuable material for hard, accurate thinking upon this subject; but we do not believe his classification will satisfy many minds. We should, however, be unjust if we did not admit the skill with which he has developed his ideas.

THE PRINCIPLES OF AGRICULTURE. By WILLIAM BLAND, M.R.A.S., Author of "Principles of Construction in Arches, Piers, Buttresses, etc." Second Edition. (*Longmans.*)—Mr. Bland is well known in Kent as an eminent authority upon agricultural questions, and he has also distinguished himself by displaying great mechanical ingenuity in various departments, boat-building among the rest. The first edition of the present work has been long out of print, and the new one, which is somewhat enlarged, and brought down to date, gives the results of experience in a manner that cannot fail to be useful to agriculturists. Mr. Bland's practical knowledge seems to us in advance of his theoretical acquirements; but the reader who gains a large amount of information from his pages, will not be disposed to cavil if, for example, he finds the word "fermentation" used in a manner that is not very clear. It is important to notice Mr. Bland's opinions on landlords and leases. He thinks "the tenant should be allowed full scope to do what he pleases till within the last three years of his lease," and that at the expiration of the lease the landlord should make an allowance for all improvements.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*April* 27.

DISCOVERY OF FISH IN UPPER LIMESTONE OF PERMIAN FORMATION.—Mr. Kirkby communicated an account of the discovery of fish remains in the upper limestone of the Permian formation. The strata were exposed in some quarries; the bed from which the fish remains were chiefly obtained was that which is known as the "Flexible Limestone."

The author stated that at least nine-tenths of the specimens belong to *Palæoniscus varians*, the remainder belonging to two or three species of the same genus, and to a species of *Acrolepis*. Detailed descriptions of the different species of fish were given, as also were short notices of the species of plants sometimes found associated with them, one of which he believed to be *Calamites aranaceus*, a Triassic species. The occurrence of *Palæonisci* with smooth scales was stated to be antagonistic to Agassiz's conclusion that the Permian species of that genus have striated, and the Coal-measure species smooth scales. Mr. Kirkby remarked that the fauna of the period appeared to be of an Estuarine character, and he expressed his opinion that the fishes were imbedded suddenly, as a result of some general catastrophe.

THE FOSSIL CORALS OF THE WEST INDIAN ISLANDS. BY MR. P. MARTIN DUNCAN.—The results of the process of fossilization, as seen in the West Indian fossil corals, is very remarkable, and has much obscured their specific characters, rendering their determination extremely difficult. Hence it is desirable thoroughly to examine their different varieties of mineralization, and to compare their present condition with the different stages in the decay and fossilization of recent corals as now seen in progress. Thus the author was enabled to show the connection between the destruction of the minuter structures of the coral by decomposition, and certain forms of fossilization in which those structures are imperfectly preserved; and he likewise stated that the filling up of the interspaces by granular carbonate of lime and other substances, as well as the induration of certain species, during a "pre-fossil" and "post-mortem" period, gave rise to certain varieties of fossilization, and that the results of those operations were perpetuated in a fossil state.

The forms of mineralization described by Dr. Duncan are—Calcareous, Siliceous, Siliceous and Crystalline, Siliceous and Destructive, Siliceous Casts, Calcareo-siliceous, Calcareo-siliceous and Destructive, and Calcareo-siliceous Casts.

In describing these forms especial reference was made to those in which the structures were more or less destroyed during the replacement by silica of the carbonate of lime of the coral.

In explaining the nature and mode of formation of the large casts of calices from Antigua, the author drew attention to the fact that the silicification is more intense on the surface and in the centre of the corallum than in the intermediate region; and, when

examined microscopically, it could be seen that the replacement of the carbonate of lime began by the silica appearing as minute points in the centre of the interspaces and of the sclerenchyma, and not on their surface. In conclusion, the influence of all the forms enumerated above in the preservation of organisms was discussed, and the relation of hydrated silica to destructive forms of fossilization was pointed out as being one cause of the incompleteness of the geological record.

May 11.

Mammalian Remains near Thame.—Mr. Codrington described a railway-cutting through a hill between Oxford and Thame which exposed a section of certain gravel-beds, from which many Mammalian remains were collected. The hill is nearly surrounded by the Thame and two small tributaries, and consists of Kimmeridge clay capped by a bed of coarse gravel overlain by sandy clay. The gravel consists of chalk-flints, pebbles derived from the Lower Greensand, and fragments of mica-schist, etc., indicating a northern-drift origin; it contained many bones of Elephant, Rhinoceros, Horse, Ox, and Deer, and a single phalanx of a small carnivore, but no flint implements were discovered.

Deposit at Stroud containing Flint Implements, Land and Freshwater Shells, etc.—In the construction of a reservoir near the summit of the hill above the town of Stroud, Mr. E. Witchell observed, about two feet from the surface, a deposit of tufa containing land-shells with a few freshwater bivalves; in it he subsequently discovered several flint flakes of a primitive type, and in the overlying earth a few pieces of rude pottery. The deposit is situated on the spur of a hill nearly separated from the surrounding country by deep valleys; Mr. Witchell considered it to be comparatively recent, and concluded that it had been formed in a pond or lake, which had been caused by a landslip from the higher ground, producing a dam that stopped the downflow into the valley of the water of the neighbouring springs.

ROYAL INSTITUTION.—*May* 6.

The Properties of the New Metal Indium.—Professor Roscoe gave a lecture on the characters of this metal, which has recently been discovered by Reisch and Richter in the Zinc blende of Freiberg, by means of the spectroscope. Indium is distinguished by having a spectrum consisting of two bright indigo-coloured lines, and by its compounds tinting the colourless flame of a Bunsen burner of a violet colour.

Hitherto indium has only been obtained in very minute quantity from the Freiberg blende, consequently its properties and compounds have not been very carefully examined. It appears closely to resemble zinc, with which it has hitherto always been found in combination. It is, however, a softer metal, marking paper like lead; it is readily soluble in hydrochloric acid, and, heated in the

open air, it oxidizes freely, yielding a white oxide easily reducible before the deoxidizing flame of the blow-pipe.

The hydrated oxide is precipitated from its salts by potash and ammonia, but is insoluble in excess of either of these re-agents; hence it is easily distinguished from both zinc and alumina.

The oxide may be separated from oxide of iron, with which it is associated in the zinc blende by precipitating the latter with bicarbonate of soda. The precipitated sulphide is insoluble in alkalies. The quantity of indium salts exhibited by Professor Roscoe consisted of about three grains; with these he succeeded in demonstrating its properties, and exhibited the characteristic indigo spectrum in a very striking manner.

Professor Roscoe also alluded to the new discoveries made with the spectroscope. Cesium and rubidium have been found to exist in many articles of human consumption, such as beet-root sugar, tea and coffee. Thallium has been found in many minerals in which its presence was hitherto unsuspected, and to occur also in very appreciable quantity in molasses, the yeast of wine, chicory, and even in tobacco.

A new and comparatively abundant source of these three rare metals, cesium, rubidium, and thallium, has been discovered; the water of a spring near Frankfort leaves on evaporation a saline residue which contains the three metals in appreciable quantity.

Recently a more attentive examination of the rays emitted by the sun's photosphere has been made, and it is found that it exhibits no trace of potassium salts. Hence that element may be regarded as being absent from the solar atmosphere.

The spectrum of burning magnesium has been found to be particularly rich in chemical rays, and has consequently been used with success as a photographic light. Professor Roscoe stated that if the surface of burning magnesium has an apparent magnitude equal to that of the sun seen from a certain point, the chemical action effected by the magnesium on that point is equal to that produced by the sun when at an elevation of 9° 53′. And that at a zenith distance of 67° 22′ the visible brightness of the sun's rays is 524·7 times that of burning magnesium, whilst its chemical brightness is only 36·6 times as great as that of the burning metal; hence the great use of the latter in photography. A thin magnesium wire produces in burning as much light as seventy-four stearine candles, and to continue this light for ten hours, seventy-two grammes—about two ounces and a half—of magnesium must be burnt, corresponding in effect to twenty pounds of stearine candles. A magnesium lamp was exhibited, consisting of a coil of magnesium wire, which was gradually unwound and burnt as it issued from a glass tube. Magnesium wire of a size convenient for burning is now manufactured by Mr. Sonstadt's process, and sold at threepence per foot; the combustion of one inch of wire affording sufficient light to take a positive picture with dry collodion. During the lecture a negative of Professor Faraday was taken; from this a transparent positive was printed by a few seconds exposure, and exhibited on the white screen by the electric lamp.

ROYAL GEOGRAPHICAL SOCIETY.—*May* 9.

A NEWLY-DISCOVERED LOW PASS OVER THE ANDES IN CHILI, SOUTH OF VALDIVIA.—Sir Woodbine Parish stated that Señor Cox had undertaken this remarkable journey with a view to discover an easy route between the new Chilian settlements on the Pacific coast in 40° and 41° S. lat. and the river Negro, which, eighty years ago, had been proved by Villarino, a Spanish explorer, to be navigable from the eastern side of the Andes to the Atlantic. He equipped an expedition at his own cost at Port Montt, a new German settlement, now containing 15,000 inhabitants, near the island of Chiloe, and proceeded in December, 1862, by way of the two lakes, Llanquilhue and Todos-os-Santos, towards the almost unknown inland sea of Naguel-huassi. He traversed the lakes by means of gutta-percha boats, and succeeded in discovering a pass over the Cordillera at an altitude of not more than 2800 feet. Arrived at the end of Lake Naguel-huassi (Lake of Tigers), which lies on the eastern side of the chain of the Andes, Señor Cox's party found a broad stream issuing from it in the direction of the rivers which flow into the Atlantic. Seven of the sixteen persons who formed the expedition embarked in one of the boats and descended the river, which is called the Limay, and forms one of the affluents of the Rio Negro. The voyage was attended with great risks, owing to the numerous rapids. At length when within five miles of the point to which Villarino had attained in ascending the Rio Negro from the Atlantic, the boat was upset, and the party fell into the hands of a savage tribe of Pampas Indians encamped near the spot. The Cacique at length promised to assist Señor Cox in reaching the Rio Negro on condition that he first went to Valdivia for presents. The re-crossing of the Cordillera, at a more northerly point, towards Valdivia, was accomplished without much difficulty: but the main object of Señor Cox's journey, namely, the opening of an easy passage across the Continent has been up to the present time frustrated by the hostility of the Indian tribes.

NOTES AND MEMORANDA.

THE SURFACE OF THE SUN.—Notwithstanding the statements of the Greenwich astronomers, the question of the rice grains or willow leaves on the solar surface is not considered to be settled. Mr. Wm. Huggins, who is an excellent observer, and possesses a fine telescope, denies that the solar surface consists of an interlacement of elongated particles, definite in shape, and uniform in size. He finds the brighter portions of every imaginable shape, and greatly differing in size. It certainly seems highly improbable that the monotony and uniformity of willow leaves or rice grains should be preserved in the face of a body that is proved by the behaviour of the spots to undergo violent changes. From the *Monthly Notices* of the Astronomical Society (1864, No. 6), it will be seen that Mr. Dawes, who is universally admitted to be one of our finest observers, affirms that "the observations of Messrs. Stone and Dunkin have landed them precisely where he was sixteen years ago." At that time he compared the bright particles scattered almost all over the sun to excessively minute fragments of porcelain; but he doubted the appearance, and after four years more research, and the

assistance of his own solar eye-piece, which permitted the use of a power of 400 to 600, he arrived at the conviction that the "brilliant objects were merely different conditions of the surface of the comparatively large luminous clouds themselves, ridges, waves, hills, knolls, or whatever else they might be called, differing in form, in brilliancy, and probably in elevation, and bearing something of the same proportion to the individual luminous clouds that the masses of the bright faculæ, as seen near the sun's edge, bear to the whole disc of the sun."

THE COMPANIONS OF SIRIUS, TRUE AND FALSE.—Mr. Dawes states, in *Monthly Notices*, that he has attained with his $8\frac{1}{4}$-inch object-glass distinct views of Alvon Clark's Companion of Sirius. Angle of position, 84°·86, distance about 10." Mr. Lassell and Mr. Marth have also observed it at Malta, their measures of position ranged from 78°·53 to 80°·29, and their distances from 9"·21 to 10"·90. The little star appeared not a very small point, but deficient in brilliancy to Mr. Lassell, and when Mr. Dawes first saw it, he turned round his object-glass and eye-pieces to be certain it was a real star. His measures were only approximate. Mr. Tempel, of Marseilles, has a letter in the *Astron. Nachrichten*, detailing his efforts to see the companions observed by M. Goldschmidt with a telescope of about 4-inches. Mr. Tempel employed one of 48 lines, which he says is a little bigger than M. Goldschmidt's, and of excellent performance on double stars. With this instrument, after many hours' observation, he saw three companion stars with magnifications of 40 and 24. He saw them less plainly with 60, and not at all with 80 and upwards. He saw similar appearances near Procyon, Capella, and β Orionis; in the latter case, in addition to the true companion. Careful experiment satisfied him that the appearances were false, and that Goldschmidt had been deceived in assigning additional companions to Sirius.

SIZE AND FIGURE OF THE EARTH.—The results obtained by our Ordnance Survey exhibit the earth as having an equatorial semi-diameter of 20,927,005 feet, and a polar semi-axis of 20,852,372 feet. The flattening being $\frac{1}{280{,}4 \pm 8{\cdot}3}$ Comparing arcs of the meridian measured in England, France, Russia, Prussia, Hanover, Denmark, and India, the Ordnance Survey gives for the average of the globe—

Semi-equatorial diameter, 20,926,330 feet.
Semi-polar axis . . . 20,855,240 feet.
Flattening . . . . . $\frac{1}{294{,}36}$

The latter calculations take in the final determinations of the great Russian arc measured by M. Struve. The French metre is thus not, as was supposed, exactly a ten-millionth part of any ascertained quarter of a meridian, nor of an average quarter meridian.

SILKWORMS OF THE OAK.—M. Guerin Méneville informs the French Academy that, in addition to three Asiatic silkworms living on the oak, the *Bombyx melitta* from Bengal, and *Bombyx Pernii* from N. China, and *Bombyx Yama-Maï* from Japan, he is trying to naturalize a fourth, the *Bombyx Roylei*, from the Himalayas, on the borders of Cashmere. On the 23rd March he received 20 cocoons. At first only males were produced, but on the 19th April he obtained a male and female moth, the latter laying 108 eggs. M. Méneville thinks it will be easy to rear these silkworms in Central and Northern France.

FUNCTIONS OF THE CEREBELLUM.—Dr. Dickinson states that experiments with reptiles and fish show that the cerebrum by itself is unable to give more than a limited amount of voluntary motion, and that of a kind deficient in balance and adjustment. If the cerebellum only be removed from fishes, there is a loss of the proper adjustment between the right and left sides, so that oscillation or rotation takes place. All the limbs are used, but apparently with a deficiency of sustained activity. From the negative results of experiments it is inferred that the cerebellum has nothing to do with common sensation, with the sexual propensity, with the action of the involuntary muscles, with the maintenance of animal heat, or with secretion. The voluntary muscles are under a double influence, from the cerebrum and the cerebellum. The anterior limbs are

chiefly under the influence of the cerebrum; the posterior of the cerebellum. Cerebellar movements are apt to be habitual, while cerebral are impulsive. The cerebellum acts when the cerebrum is removed, though when both organs exist it is under its control.—*Proc. Roy. Soc., No.* 63.

Toning Bath for Albumen Process.—In reply to one of our correspondents, who has requested us to give a good formula for a *toning bath*, we select the following out of a great number at present in use, as, in ordinary circumstances, among the most convenient and effective. Place one litre of distilled water, and then two grammes of chloride of gold in No. 1—a bottle with a cork: one litre of distilled water, and then twenty grammes chloride of lime in No. 2—a bottle with a ground-glass stopper: one litre of distilled water, and then five grammes of common salt, in No. 3—a bottle with a cork. All the chloride of lime will not be dissolved; but what remains at the bottom of the bottle will keep the fluid saturated, which is necessary:—before being used the required quantity of it must be filtered. The toning bath is made as follows:—To one litre of distilled water is added 60cc of the fluid in bottle No. 1, 20cc of that in No. 2, and 15cc of that in No. 3. The mixture should be limpid, and either colourless or of a light yellow tinge. It must be used at once, as it will not keep. According to the time during which the proofs are immersed in it, the shade will vary from some tint of blue to a deep black: a dark violet being produced in moderate weather in about twenty minutes—in cold weather a longer time will be required. The whites will be beautifully bleached by the free chlorine. A litre of this mixture will tone about 70 cartes de visite. They must be moved about in it, and occasionally taken out, and replaced. The quantity required for any number of proofs of any size may be easily calculated.

Earthquake in Sussex.—On the 30th April a shock was felt in several places in Sussex, Lewes included. The strongest effect is reported to have been felt at Chailey. A lady at Lewes heard a noise like hail shortly after midnight (31st). At Fletching the people supposed a gunpowder explosion had occurred.

Conical Hail.—M. J. A. Barral describes to the French Academy some hailstones that fell in Paris on the 29th March, 1864. They were of conical shape, slightly concave at the base, and fell point downwards. The cones were eight or ten millimètres in diameter at the base, and ten to thirteen millimètres high. They seemed to be formed by the adhesion of small pyramids, leaving a little hollow inside.

Great Crocodile of the Oolite.—M. A. Valenciennes exhibited to the French Academy on the 11th April a fossil crocodile tooth found in the Oolite, near Poitiers. From its size he estimated the animal to have been one hundred feet long. This creature must not be confounded with the megalosaurus.

Comparing the Light of Stars.—In *Comptes Rendus* for the 11th April M. Chacornac describes a method of mounting a plane mirror so as to bring into the field of a telescope the image of one star, while the telescope receives directly the light of another. By this means the two images are brought into simultaneous view, the one of course less brilliant than it should be, through loss of light in reflection. He gives the calculations necessary to work out the comparison. Sirius he finds to be five times as bright as Arcturus. He is able to work by this method upon stars from 20° to 160° apart. When seen simultaneously, Arcturus looks orange red, and Sirius has a slight green tint.

The Moth of the Ordeal Bean—Insensibility to Poison.—Dr. Fraser shows in the *Annals of Natural History* that the caterpillar of *Deiopeia pulchella* can eat the poisonous ordeal bean of Calabar with impunity, and is in the habit of boring holes in it. This caterpillar is readily killed with hydrocyanic acid, while the *Anthonomas druparum* can live upon the kernel of the Prunus cerasus that contains it.

Grafting Animals.—Dr. Paul Bert has published a work on the curious subject of animal grafts. He succeeded in making Siamese twins of a couple of rats, and in many other monstrosities. He exclaims, "it is a surprising spectacle to see a paw cut from one rat live, grow, finish its ossification, and regenerate its

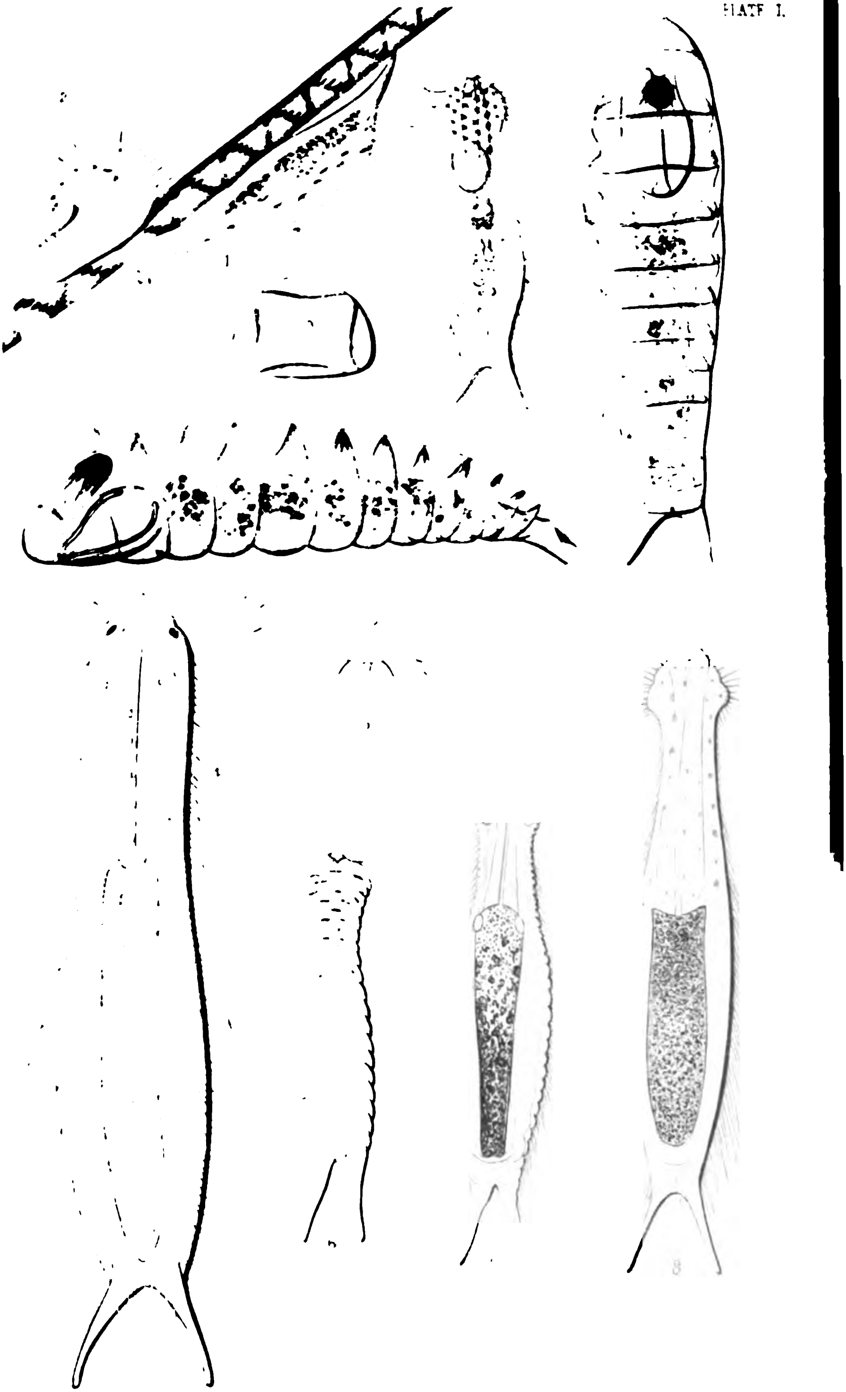
nerves, under the skin of another, and when we plant a plume of feathers under the skin of a dog, what a miracle to see the interrupted vital phenomena resume their course, and the fragment of a bird receive nourishment from the blood of a mammal."

FORMATION OF THICK ICE.—M. Lucien de la Rive has recently read an elaborate paper on the Conductibility of Heat by Ice, before the Societé le Physique and d'Histoire Naturelle de Genève, which is reprinted in the *Archives des Sciences*. In this essay he enters, amongst other things, on the time required to form thick masses of polar ice by gradual freezing of the water touching their lower surfaces. One metre in thickness would, he states, require 1·42 years, 10 metres 142 years, 100 metres, 14,200 years, 200 metres, 56,800 years. The huge masses seen by Scoresby and others, having a probable thickness of 200 metres, may have grown by snow falling on their upper surfaces; but if it were possible to determine by difference of structure what portion resulted from this cause, and what was produced by additions from below, the time consumed in the formation of the latter might be computed according to the formulæ which M. de la Rive gives.

VIEWING TADPOLE CIRCULATION.—Those who are not familiar with the best arrangements for this purpose should consult Mrs. Ward's excellent *Microscope Teachings*. All but the very youngest tadpoles are too thick for the live box; older ones may be placed, as in Mrs. Ward's sketch, on a slide, and partly covered with a little tuft of wet cotton wool. They will generally be quiet enough without tying down. When the gill circulation is to be viewed, the cotton should be placed over the tail, and when the gills have disappeared, and the tail circulation becomes a beautiful spectacle, the cotton should be placed over the creature's head and body.

CURE FOR HOOPING COUGH.—The *Courier du Pas du Calais* mentions several instances of the cure of hooping cough by inhalation of the vapours evolved by the lime used in purifying coal-gas. It affirms that two or three visits to the gas-works have usually proved sufficient.

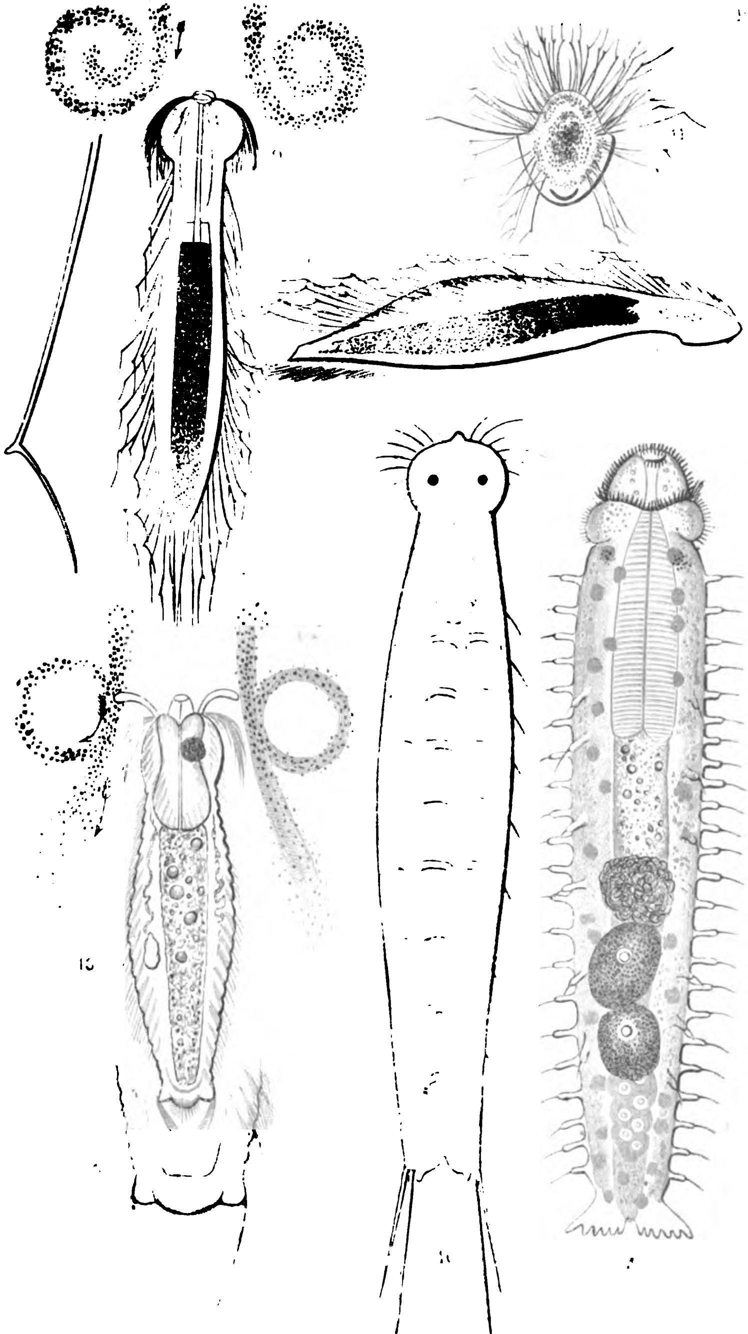
MR. GLAISHER'S 18TH ASCENT took place on the 6th of April, at 4·7 p.m., from Woolwich Arsenal. The sky was overcast at starting, and had been so all day, wind S.E. The balloon crossed the river into Essex; at 500 feet elevation the air was very misty, and increased in density as the balloon rose; at 2000 feet wind was SW. or WSW.; at 2500 feet dense white cloud; at 3500 feet thin rain; at 4000 feet clouds less dense, and increase of light; at 4500 feet sun seen faintly; at 5100 feet the sun cast a faint shadow, but cloud continued up to 6500 feet; the air was still misty, and after reaching 8100 feet mist increased till the height of 9000 feet; at 9500 feet bright sunshine, and it was quite warm. At 10,000 feet Mr. Glaisher says, "We were quite out of the cloud, and there was a sea of white cloud, dazzling in its brightness, extending without break or irregularity in its surface as far as we could see all around, that is, for more than 100 miles on all sides; near to us on the cloud on the side opposite the sun was a bright oval halo of immense extent, in the centre of which was situated the shadow of the balloon and car, but without prismatic colours. This all appeared to revolve with us, for it was constant, and we knew we were turning round by the sun now shining on our backs and then in our faces. At the greatest elevation, 11,000 feet, there was perfect repose, the sky was without a cloud, of a beautiful deep blue." The temperature on leaving was 46°; at 1000 feet, 41½°; at 1500 feet, 40°; at 2000 feet, 37°; at 3000 feet, 32°; from 3500 to 4000 feet, no variation from 33°; at 5000 feet temperature rose to 36°; at 8000 feet, 40°; at 9000 feet, 34°; between 10,000 and 11,000 feet, 46°. In descending, the highest temperature was at 8000 feet, 46°, at that elevation it is usually 30° to 40° lower than on the earth. Within two miles of the earth totally opposite currents were found. No ozone was detected.



P. H. Gosse, ad v.v.

HAIRY-BACKED ANIMALCULES.
Chætonotidæ.

1. Chætonotus larus, crawling on a thread of Conferva; 2, in the act of turning; 3, viewed from above. 4, C. [illegible]; 5, the mouth and oculiform specks, more highly magnified. 6. C. squammatus. 7. C. Slackiæ. 8. C. gracilis. 9, Taphrocampa annulosa, viewed from above; 10, viewed from the left side; 11, ideal transverse section.



P. H. Gosse, ad v. ...

HAIRY-BACKED ANIMALCULES.
Chætonotidæ.

9. Dasydytes goniathrix, viewed from above; 10, viewed from the right side; 11, viewed from the front; 12, one of the bristles greatly magnified. 13. D. antenniger; 14, the caudal pencils more highly magnified. ... hyalina, after Schultze. 16. Echinodera Dujardinii (after Dujardin).
N.B.—All the figs., except 5, 13 and 14, are magnified ... diam. and all except ...

THE INTELLECTUAL OBSERVER.

JULY, 1864.

THE NATURAL HISTORY OF THE HAIRY-BACKED ANIMALCULES (CHÆTONOTIDÆ).

BY PHILIP HENRY GOSSE, F.R.S.

(*With Two Plates.*)

WHOEVER has been in the habit of collecting the floccose matter that accumulates around the submerged stems of aquatic plants, or the impalpable sediment that lies at the bottom of still pools and running ditches, and of examining the same in the live-boxes of his microscope, is aware how abundant and how various are the forms of life that are presented to his view. Creatures the most strange and the most incongruous—odd in their shapes, odd in their structure, odd in their manners, odd in their movements, swim, or rotate, or creep, or wriggle over the field of vision, till the little pellet of brown mud, no bigger than a grain of duck-shot, flattened out before him, proves a complete microcosm. Many such pellets will not have passed under the eye of the curious observer before he will pretty certainly have become familiar with a little creature of attractive appearance and lively manners, which forms the typical representative of a limited group of animals, whose family name I have set at the head of this article. Dr. Ehrenberg, of Berlin, named it the Bristle-fish (*Chætonotus*), both of which appellations allude to the long and stout bristles with which its back is beset in rows. Its movements are not so rapid as those of many animalcules, and therefore it affords a fair object for the young microscopist, while its form is so peculiar as to be easily recognized. When enclosed in an aquatic live-box, it is fond of crawling on the surface of the glass cover, whereby we distinctly see the ventral surface, as we see the lateral form when it creeps about the stems. The form, when seen vertically, is somewhat fish-like, with a thick, blunt, and rather triangular head, and a slight constriction or neck; a swelling body, terminating in two diverging points. The figure, when

seen sidewise, reminds one of that of a ferret, the back being much arched (Plate i. Fig. 1). The whole body appears covered with hairs, which are set in rows; those on the front part are smaller and closer, those on the back larger and fewer. The fore-part, seen from beneath, presents an appearance of hatching or cross lines running diagonally, or else of dots set in quincunx, which I suppose are the bases of the hairs growing in such an arrangement. The internal structure is not usually discernible; for though the body is pellucid and colourless, and often lustrous from the refraction of the light, especially through the neck, the number of hairs which stud the surface prevent a clear sight of the interior. Two bands, which run down the belly, are understood to be bands of cilia. There is a certain nimbleness and sprightliness in the motions of this pretty animal as it crawls, frequently turning short on itself and changing its course (see Fig. 2), examining various objects, much like a caterpillar does, with apparent intelligence. I shall return to this species again for fuller details; but this general description will help the reader better to understand the group of which I propose to treat.

The form appears to have been recognized in the earliest records of microscopic observation; for Joblot, nearly a century and a half ago, described an animalcule, which was probably enough this very creature, under the title of "Poisson à tête tréflée." I say "probably," because an *approximation* to the general outline of such minute creatures was all that, with their very imperfect instruments, the early observers could accomplish. About sixty years later Müller, the great Danish zoologist, and the first who attempted to define and arrange the host of microscopic animalcules that were crowding upon observers, described under two names—*Cercaria podura* and *Trichoda larus*—what may have been two species of the same family, or one. The two specific names have, however, been adopted in modern nomenclature, as representing two distinct creatures, the latter being appropriated to the one I have described; though on what account he applied the name *larus*, which signifies *a gull*, to it, I cannot conjecture. Passing by other observers, who have recorded nothing more worthy of note concerning the form, than that they recognized it, we come to Ehrenberg, who, in his valuable papers in the Transactions of the Berlin Academy for 1831, and afterwards in his notable work *Die Infusionsthierchen*, determined the two genera, *Ichthydium* and *Chætonotus*, for the two species described by Müller, adopting his specific names, and added two more species to the latter genus.

The great Prussian zoologist included these creatures among the Rotifera, uniting with them in the same group two other

genera, which have no real affinity with them, his system of arrangement being artificial, and therefore, necessarily, in some cases, unnatural.*

M. Dujardin, in 1841, described another species, which he named *Ch. squammatus*, and rejecting Ehrenberg's arrangement, united the then known forms with others, with which they have no more affinity, and placed the heterogeneous group among the Infusory animalcules by the name of *Symmetrical Infusoria*. His ground for the change is thus expressed:—"The Ichthydina, according to M. Ehrenberg, ought to have a rotatory organ, simple, continuous, with an entire margin; but, in fact, the vibratile cilia of the ventral surface of the Chætonotes do not at all constitute a rotatory organ."†

Ten years later, the same zoologist described another form (Plate ii. Fig. 16) under the title of *Echinodera*,‡ apparently allied to the same group; to which, however, he now assigned a higher place, viz., intermediate between Crustacea and Vermes. He believes that this is "a type differing from the *Helminthes acanthocéphales*, the *Systolides* [Rotifera], the *Entomostraca Copepoda* [Cyclops, etc.] and the Sipuncles, yet at the same time offering points of resemblance to each of these. It is a sort of *Copepode* without feet, with the mouth of a *Sipunculus*, and the neck of an *Echinorhynchus*, and a muscular œsophagus like those of the *Systolides*, the *Tardigrades*, and the *Nematoid Helminthes*."

M. Perty§ and Herr Vogt|| concur in the exclusion of the *Chætonotidæ* from the ROTIFERA; the former, however, has not ventured to assign them any definite position, while the latter associates them with the Planarioid worms (TURBELLARIA).

* It is the fashion to depreciate and decry Ehrenberg. I have no sympathy with those who, taking their stand upon the ground which he has cleared with incredible labour and genius, can assume airs of pity or contempt when they discern inconsistencies or defects in his system. Many years' study of the Rotifera has enabled me in some measure to appreciate the gigantic labours of the Prussian microscopist, and to compare them with those of his successors and critics. I take, for example, Dujardin's *Hist. des Infusoires*, and have no hesitation in asserting that this work does not manifest one-fourth part of the real actual acquaintance with the subjects treated, that is possessed by Ehrenberg's great work. Corrections and improvements in some points cannot fail to be pointed out by those who begin where the Prussian left off; and the advance of science, and the improvement of the microscope itself, have, of course, made antiquated and displaced many of his statements and conclusions; but, looking at microscopic zoology as it was when Ehrenberg took it up, and as it was when he laid it down, I think it not too much to say that he stands in the foremost ranks of the scientific army, side by side with such names as Aristotle, Linnæus, and Cuvier, and that his *Die Infusionsthierchen* is a monument to his fame, *ære perennius*, and such as few indeed have been able to erect.

† *Hist. des Infus.*, p. 569.

‡ *Annal. d. Sci. Nat.* 1851. The name is erroneously spelled "Ellimoderia" in the 4th Ed. of Pritchard's *Infusoria*, p. 380.

§ *Zur Kenntniss kleinster Lebens formen.*

|| *Zoologische Briefe.*

Dr. Max Schulze, describing yet another genus, *Turbanella* (Pl. ii. Fig. 15), in 1853,* took occasion to institute an elaborate examination of the structure of the whole group, augmented by all these discoveries. He considers that it does without doubt fall within the great circle of VERMES, though there is some difficulty in determining in which class to place it. Its union with the ROTIFERA he judges impossible: 1, because of the absence of the vibratory organs around the mouth, so characteristic of that class; 2, because muscles, nerves, and water-vessels—organs which are wanting in no true Rotifera—have not been found in this group; 3, because of the absence of a caudal extremity, furnished with articulated members; and 4, because of the peculiar cilia with which the ventral surface is clothed in the Chætonotes. *Turbanella* shows traces of a division into segments in the separation of the head from the rest of the body, in the ring of cilia which surrounds the head, and in the position of the almost regularly recurring lateral processes, and thus reminds us, in its ciliation and its obscure articulation, of several states of development of the true ANNELIDA. I may add, that the *Echinodera* of Dujardin, and my own curious genus, *Taphrocampa* (Figs. 17—19), presently to be described, carry this appearance of segmentation still further, and, *pro tanto*, strengthen the grounds of affinity with the ANNELIDA.

Dr. Schulze cites the analogy of certain Annelida, which possess, even in the adult condition, a ciliated skin. *Polyophthalmus* (Quatref.) has a ciliary head-veil, not unlike that of the Rotifera. The genus *Spio* is provided, according to Oersted (confirmed by Schulze's own observations), with ciliated gill-leaves; its two long frontal cirri are also ciliated, and so are the pair of longer appendages, which, seated on the second segment, project at right angles from the body, as noticed in a species found at Cuxhaven.

The claim of the TURBELLARIA to afford a refuge for these strangers, which, like homeless paupers passed from parish to parish, are found so difficult to settle, is next brought under review. All the Vortex-worms have a ciliated covering, spread entirely and uniformly over the body; their skin is soft and melting; their digestive canal is destitute of a firm envelope, and is separated from the soft parenchyme of the body only by its wall, formed of peculiar digestive cells, or hepatic cells. Muscle-threads, the central portion of a nervous system, and water-vessels, are recognized in all these worms.† In *Chæ-*

* *Archiv f. Anat. Physiol., etc*, 1853, p. 241, *et seq.*

† "In *Microstomum lineare*, in which neither Oskar Schmidt nor I could formerly discover any trace of a water-vascular system, I have lately recognized such, furnished with very small tremulous tags, and also distinct muscle-threads."—*Note by Dr. Schulze.*

tonotus and *Turbanella* the skin is not melting, but capable of resisting, to some extent, cold potass solution. It is ciliated only on the ventral surface, and, in the former genus, only on a portion even of this. The ring of cilia which surrounds the head of *Turbanella,* and the muscular coat of the alimentary canal of the Chætonotes generally, sharply defined against the parenchyme of the body, especially in the anterior third, are conditions unknown among the *Turbellaria;* while the motory muscles, nerve-threads, and water-vessels common to them, have not been recognized in those. Yet Dr. Schulze judges that a certain relationship between the *Chætonotidæ* and the TURBELLARIA is not to be mistaken: 1, because of their inarticulate body, in size and form resembling the little Vortex-worms; 2, because of the absence of any other locomotive organs than skin-cilia, by means of which, though covering only one half of the body, the animals yet proceed with a soft gliding motion, like that of the Vortex-worms; 3, because the absence of muscles, nerves, and vessels is approached by the obscure condition and receding development of these organs in many of the more minute *Rhabdocœla* and *Microstomata.* Thus there seems here a closer affinity than with the ANNELIDA.

Difficulties, however, beset the attempt to assign to the *Chætonotidæ* their natural place in the class TURBELLARIA. The *Dendrocœla* and the *Rhyncocœla* are at once excluded; the former consisting of animals of superior size, furnished with a ramified intestine without an anal orifice; the latter having, indeed, a straight intestine, provided with an anus, but invariably possessing a protrusile proboscis. There remain the *Rhabdocœla* and the *Arhynchia.** Both these groups contain small forms, resembling those of the *Chætonotidæ;* but the former have an intestine without an anus, and a hermaphodite system of reproduction; the latter an anal orifice, but a diœcious reproduction. Thus the *Chætonotidæ,* hermaphrodite and furnished with an anus, cannot, without force, be referred to either.

In the TURBELLARIA, as in the VERMES generally, those characters which are drawn from the form of the alimentary canal have a higher systematic signification than such as depend on the condition of the reproductive system. If the *Chætonotidæ,* then, are to be placed among the TURBELLARIA, Dr. Schulze would associate them, not with the *Rhabdocœla,* but with the *Arhynchia;* which would include the *Microstomata* and *Dinophilus* as diœcious, the *Chætonotidæ* as monœcious forms.

Finally, this able zoologist, taking into consideration all the facts recorded, considers it premature to determine the actual

* Vide Schulze's *Beitr. z. Naturg. d. Turbellarien.*

relation of the family in question. Assigning to them a provisional place among the TURBELLARIA, as just indicated, he admits that further investigations of the anatomy of this little examined group may bring to light relations hardly suspected; while many forms more or less closely allied may still lurk undiscovered, acquaintance with which may modify our already accepted conclusions. Dujardin's curious little *Echinodera*, and my own equally anomalous *Taphrocampa*, appear, for example, to widen the distance between the group and the TURBELLARIA; while, in their more strongly marked segmentation they show a decided approach to the Annelidous forms.

Having thus given to the reader an abstract of the views of one of the most learned of Continental zoologists on this obscure group, I proceed to describe all the species as yet recognised in it, premising that I have myself met with some, manifestly belonging to before-unknown genera, and other species which seem irreconcileable with published descriptions and figures of such as had been recognized. These I propose to include.

FAMILY CHÆTONOTIDÆ.

I think it desirable that the family should be named after the most characteristic and most populous genus, which is indubitably *Chætonotus*, and not *Ichthydium*. It consists of soft-bodied animals microscopically minute, of lengthened form, having a bilateral symmetry, with a more or less distinct separation of the head; the body more or less clothed with vibratory cilia, and for the most part with long hairs; the alimentary canal straight, and furnished with an orifice at each extremity. Inhabitants of fresh-water.

Genus I.—ICHTHYDIUM (*Ehrenberg*).

Posterior extremity forked; body unfurnished with hair.

Sp. 1. I. podura (*Müll.*) This form has been often seen by the early observers, if we can be quite sure that it has not been confounded with *Chæt. larus*. Ehrenberg first certainly defined it, having met with it in Nubia, among conferva from the Nile, and subsequently near Berlin. The body is linear-oblong, with the anterior extremity swollen; sometimes three-lobed; often slightly constricted; the hind fork short. The ventral surface is flat, the dorsal arched, and destitute of hair. The largest specimens have not the least vestige of hair on the back. The animal is colourless or whitish, but sometimes tinged with yellow, through the distension of the wide intestine. A longitudinal band of cilia was in one specimen clearly seen by Ehrenberg, along the belly, but in other individuals,

though of large size, he could not with the utmost care discern it directly, though he saw a distinct rotation at the mouth. It swims more rarely than it crawls. Our specimen showed, in the hinder part of the thick body, a large dark egg, well developed.

This species appears to be rare; I have not myself met with it, nor have I noticed any record of its occurrence since the publication of Ehrenberg's observations.

Genus II.—Chætonotus (*Ehr.*).

Posterior extremity forked; body clothed with hair.

Sp. 2. C. larus (*Müll.*) (Pl. i. Figs. 1—3.) This is the most commonly observed species of the whole family, being very frequently met with among duckweed, conferva, and other aquatic vegetation. It is of moderate dimensions, as compared with others, ranging from 1-400th to 1-200th of an inch in length. Its body is not quite four times as long as broad; the head is roundish or obscurely triangular, passing insensibly into the thick neck which separates it from the swelling abdomen. The posterior extremity is deeply forked, the two divergent toes tapering to points, which are sometimes obtuse. Ehrenberg distinguishes the species by its having the hairs on the hinder portion of the back longer than those on the fore part; and in this distinction I concur with him, the specimens that I have seen possessing the character strongly marked, sometimes excessively. These long hairs are few, and spring out of a dense coat of short hair, which clothes the whole body, but most thickly behind. Probably this is what M. Dujardin refers to when he remarks that "looking at it in profile we recognize that the back is covered with asperities from between which the long straight hairs spring." * No one that I am aware of has remarked a curious circumstance, that the sides of the head are furnished (Fig. 3) with some very long slender hairs, which stand out laterally, diverging, curving slightly forward, like the whiskers of a cat. I have observed the animal frequently bend and straighten them rapidly, near the tips, one independently of another, with a movement very different from an ordinary ciliary vibration. A strong ciliary current is produced on each side, by which floating atoms are drawn towards the head, and then rapidly hurled about halfway down the body. Vigorous ciliary currents are seen to pass along the inferior surface of the neck: I have not often been able to define these as forming two bands, though occasionally they are traceable, reaching nearly as far as the bottom of the posterior cleft, and then turning abruptly up and run-

* *Hist. d. Infusoires*, p. 570. See, however, *infra*, under *Das. antenniger*.

ning forward along the sides. The mouth appears to me oval, minute, slightly protrusile; Ehrenberg describes it as a tube furnished with eight teeth. It leads into a gullet with very thick transparent walls, and a very slender perforation, which, at about one-third the total length of the animal, enters a straight intestine, of equal diameter with the gullet-wall. This, as I have seen it, has been generally colourless, loosely filled with irregular clear masses, and apparently terminating at a curved transverse line, considerably above the fork. This line is doubtless the outline of the swollen arched back, and marks the position of the cloaca, which, as is frequently the case, is visible only at the instant of its function. Ehrenberg has induced the digestive organs to receive indigo. The same observer has frequently seen a large developed egg contained in the ovary, which occupies the arched cavity of the abdomen, situate over (that is, more towards the back) the intestine. The egg is about one-third as long as the whole animal. I have seen the reproductive system in an inactive condition, merely as clear, refracting viscera of large size, and irregular shape, lying in the abdominal cavity, occasionally extending forward to the neck. On one occasion I am pretty sure that *I saw, for a portion of its length, a tortuous water-vessel,* running down one side. (See Fig. 3.)

The movements of this little animal are smooth and graceful, a sort of gliding or creeping over the water-plants; rarely swimming. Once I saw a *Paramœcium* come blundering up against an unsuspecting *Chætonotus,* who instantly doubled his pace as if frightened, but soon recovered his equanimity. Mr. Slack says, that among threads of conferva or decayed vegetation, he has observed it grope about, and shake them like a dog. (See *Marvels of Pond Life*, p. 84; where are two excellent figures of the species, and some interesting notes of its manners.)

Sp. 3. C. maximus (*Ehr.*) (Pl. i. Figs. 4 and 5). This is about twice the size of the preceding, measuring from 1-120th to 1-200th of an inch. The body is lengthened, slightly constricted, with the head turgid and obtusely triangular; the hairs on the upper surface short and equal. Such is Ehrenberg's definition of the species, who adds that the mouth is furnished with about eight feeble teeth (possibly papillæ). The distribution of the bristles in one he observed in distinct longitudinal rows; in another the arrangement appeared irregularly diagonal. A single egg is developed at once, greatly dilating the dorsal region of the abdomen, which Ehrenberg saw discharged by the cloaca above the foot-fork; he saw the germ-vesicle distinctly.

Dr. Schulze suggests the possibility that this species and

C. larus may be identical; but surely without good reason. He has added a good deal to our knowledge of its minuter anatomy; in particular he does not find the bristles of equal length, but longest on the back and hind end; and states that each is a pointed spine *furnished with two minute subordinate spines, one springing on each side of its base.* These spines are processes of the skin, not hairs inserted into it; but they are dissolved by potass more readily than the skin itself. The belly surface is quite destitute of spines, but it is uniformly clothed on the anterior half with short cilia, which on the posterior half are ranged in two bands along the edge, uniting above the fork. The median line of the belly is clothed with a row of short stiff down lying backwards.

The mouth, surrounded by eight or ten long, soft, and immoveable slender hairs, is formed by a circular membrane, either finely plaited, or beset with minute prominences ("teeth" Ehr.), protrusile, in the form of a short tube. Schulze recognizes the great egg with its germ-vesicle, and adds that it is covered with a shell, which potass does not dissolve. He also finds in front of the ovary a cellular spermatic gland, and two groups of spermatozoa; but fails to detect any trace of nerves, muscles, water-vessels, or tremulous tags.

In August, 1851, I found in a dyke near Stratford a very large *Chætonotus*, which I am disposed to refer to this species. Its length was 1-70th of an inch, its greatest width 1-400th (but including the bristles 1-300th); length of the toes 1-580th. The dimensions, equal to those of a full-grown *Notommata aurita*, rendered it distinctly visible to the naked eye, and marked it from all others known to me. It was equally marked by its dense coat of rigid, spinous bristles, set all over the body on the upper surface and sides, and which are longer towards the hinder parts. The toes are small, slender, slightly knobbed and incurved; they can be made to approach, and even to cross each other. On the anterior half of the body the bases of the bristles are evidently set in quincunx in about eight rows visible; the spots are very distinct and strong. On the posterior half, the increased length and decumbency of the bristles cause a brown opacity and roughness; through which, however, the cylindrical intestine can be seen by focussing. The head is but slightly lobed, and the neck scarcely at all constricted. The mouth consists of a short tube, evidently protrusile, with a dark oval speck at the bottom in the centre, where a straight slender tube originates, and passes through a wide cylindrical œsophagus to the intestine, the head of the latter embracing its fundus. On the front and at each side of the head are very delicate curved hairs like vibrissæ. Just below the lower edge of the mouth are placed two minute hooked organs, the

end of which seem thickened and are bent downwards. Oval clear specks, one on each side of the face, may be eyes. (See Fig. 5.)

The manners were much like those of the rest of the genus. It was restless, crawling impatiently among the little masses of sediment, frequently turning itself double, and sometimes coiling almost into a circle; perpetually shortening and lengthening the head, protruding the mouth, and searching with the fore part, like a caterpillar. It sometimes swam briskly.

A much smaller individual, from the same dyke, had the bristles much fewer; they were, however, very coarse, and rigid and curved. A row of fine close-set vibrating cilia run along the side besides the bristles. I think it was a young one of the same species.

In a specimen recently dead, and lying on its side, I saw the lateral form of the mouth, and the traces of tooth-like striæ that surround it. I saw no bristles along the belly line, but they covered the whole sides. Certain irregular lines may possibly have been folds of the skin. The intestine was decurved, and terminated considerably short of the fork; it appeared to have a distinct portion at its anterior end, separated by a diaphragm. The toes were decurved. *I did not notice* the peculiar structure of the bristles observed by Schulze, but cannot affirm that it was not present.

Sp. 4. C. brevis (*Ehr.*). This is characterized by its minute dimensions, being only 1-430th of an inch in length, and by its having several eggs developed simultaneously, which are proportionally smaller. A doubtful species, and one which has not, I believe, been recognized by any other observer.

Sp. 5. C. squammatus (*Duj.*) (Pl. i. Fig. 6.) The hairs enlarged in the manner of scales, regularly imbricated, distinguish this species. M. Dujardin found it in January 1840, in a bottle of fresh water which he had kept for more than a year, having brought it originally from Paris to Toulouse.* On the upper surface it appears clothed with scales ranged in seven longitudinal rows, but on a side view these are seen to be the bases of short hairs which cover all the back, and even the forked foot. The mouth appeared surrounded by four or five papillæ, only occasionally visible. The vibratory cilia of the ventral surface are very long, especially on the anterior portion.

In 1850 I found what I presume to be this species, in a tub of water exposed in my garden for the propagation of Rotifera. A description, made at the time, without any knowledge of Dujardin's observations, I subjoin. Length 1-170th of an

* Pritchard (*Infus.* 4th Ed. p. 662) by mistake says "*sea* water *from* Toulouse."

inch. In form this resembles *C. larus*, being rather broad in proportion to the length. At first sight the body seems quite smooth, but on bending strongly to either side, it is seen to be clothed with hair, as it were agglutinated in locks, like human hair wetted; for these locks then separate. The outline of the head is slightly five-lobed, and on each side of the face there are several long slender bristles diverging laterally, like the whiskers of a cat. Along the ventral surface run two rows of vibratile cilia, extending the whole length; they appear to be longest near the front. I distinctly saw them in vibration throughout, and the motion communicated by them to the floating atoms was strong and conspicuous; these, however, were hurled backwards longitudinally only, with no trace of vortices.

The mouth, œsophagus, and alimentary canal do not differ from those of the next species; but the surface of the body presents something peculiar; it appears to be thrown into a number of transverse or annular wrinkles, possibly produced by the arrangement of the hair in locks. On the front third a number of transversely oblong dark spots are seen, arranged quincuncially with much regularity; their nature I could not determine, unless they also be divisions of the matted masses of hair; they are certainly not spots of positive colour. The whole animal is colourless; the intestine was granular, but appeared empty; it would not imbibe carmine. No reproductive organs were discernible. The forked toes are blunt at the tips; they are sometimes widely separated; that they are soft was manifest when one was bent by pressure against the glass, as the animal turned. It possesses the power of contraction and elongation to a slight extent; in the former the transverse wrinkles become more distinct, and the animal becomes shorter and broader. My specimen was very active, crawling nimbly, and swimming with much swiftness, but in an unsettled wandering manner. The body is very flexible, frequently turning so short as to be bent double.

Sp. 6. C. Slackiæ (*Gosse*). (Plate i. Fig. 7.) This undescribed species I venture to dedicate to a lady, to whose facile and elegant pencil microscopists are so much indebted for the beautiful and truthful delineations of *The Marvels of Pond Life.* I obtained it in January, 1851, from the sediment of the garden-tub already alluded to. Its length was 1-135th of an inch; its greatest breadth 1-600th. The proportions are nearly those of *C. larus*, but the outline of the head is the half of a short ellipse, without lobes, and it passes, with an abrupt angle, into the neck, which is somewhat more slender in proportion to the body than in the species just named. This form of the head gives a peculiar aspect to the physiognomy, and is the first appearance of a

character which is more marked in the following species, and more strongly still in the genus *Dasydytes*. The upper surface of the body is conspicuously studded with quincuncial dots, the optical effect of what I judge to be tubercles or warts so arranged, from which, perhaps, the hairs spring. (In the engraving I have not indicated this reticulation, that I might display more clearly some important particulars of the internal anatomy.) The back and sides are clothed with very fine hair of only moderate length, which is directed backwards. I did not detect any trace of facial vibrissæ.

The mouth is rather larger than usual, abruptly narrowed behind. The œsophagus is of the normal form, a cylinder with very thick transparent walls, centrally pierced by a slender tube. I was surprised to observe that the œsophagus did not embrace the mouth, but appeared to commence just behind it, by a peculiarity of structure not easy to explain (perhaps a sudden dip or angle carrying it out of focus, though in incessant manipulation, such a circumstance could scarcely have been undetected), apparently with a depressed centre, where the medial perforation began. (See Fig. 7.) Imbedded in the exterior wall of this viscus, on each side of its summit, was a minute oval dot, well defined, which at times appeared to have positive colour, and which reminded me of the eye-specks of Rotifera. At the posterior extremity of this perforated viscus (which in ignorance we call the *œsophagus*), about one-fourth of its length, having a vaulted figure, seemed separated by a delicate bounding line from the rest. The posterior extremity was slightly excavated, and seated upon the correspondingly convex summit of the intestine,—another deviation from the normal condition, in which the intestine embraces the œsophagus in a hollow. On each side of the summit of the intestine an oval clear vesicle was seated, having the appearance, situation, and doubtless function, of those glands which, in almost all Rotifera, we assume to be pancreatic.

But the most interesting result of examination was the indubitable discovery of a water-system on the plan of that of the Rotifera. Serpentine vessels ran along each side of the body-cavity (two visible on one side, one only on the other), which could be traced very distinctly (especially when the animal bent itself laterally) nearly to the fork, and in front to the occiput, where each ended in a clavate bulb. Immediately in front of this pair of bulbs, but not having any visible connection with them, were two globular vesicles, which refracted the light strongly, and were probably filled with some fluid. These were not distinct in the same focus that defined the minute eye-like specks, and hence must have been in the opposite (ventral) region of the head-cavity. After a while, one only of

these could be found, the other having vanished. Are they, then, contractile vesicles? The other viscera presented nothing remarkable.

Sp. 7. C. gracilis (*Gosse*). (Pl. i. Fig. 8.) This elegant species, which I obtained from a pond near Leamington, in July, 1850, is remarkable for the slenderness of its form, which is not broader than that of *C. larus*, while it is about twice its length. The head is dilated at the occiput, where it is abruptly joined to the narrow neck, somewhat triangular, divided into five well-marked rounded lobes, and fringed on each side with laterally-diverging straight hairs. In the middle of the frontal lobe is pierced the mouth, which is of the same form as in *C. Slackiæ*, with slightly protrusile lips. The œsophagus is of the ordinary form, but its anterior extremity is conterminous with the front of the head, with no such structure, and no such accessories as are seen in the species just named. Its length is unusual, for it extends nearly to the middle of the body, where, just before it enters the intestine, the thick muscular wall suddenly narrows, till it seems commensurate with the tube itself. The intestine is concave at its commencement, or rather, perhaps, it is furnished with a pancreatic gland on each side, which, as is frequently the case in the Rotifera, is pointed and ear-like. This suggestion, however, rests merely on the form; for I have not detected any bounding line between the points and the intestine, nor was their substance clear, but densely filled, as was that viscus, with finely granular matter. The rounded termination, marking doubtless the position of the cloaca, is on the descent of the back, some distance in front of the foot-fork.

I was not able to discern any internal organs besides the alimentary canal, though the opacity caused by the hairs was much less than usual. The anterior half of the body shows the bases of the hairs, like very delicate dots set in quincunx. The sides and back are armed with fine bristles curving backwards. The points of the foot-fork are slender, sub-cylindrical, and slightly dilated at the lips, which are decurved.

The animal crawls impatiently about, apparently seeking for food; for I several times saw it eagerly snap at a Monad, that roamed near, opening the mouth at the same moment. Once *I believe* I saw it seize and swallow the prey, though as it was the work of an instant, I could not be quite certain. I have obtained but one specimen of this species.

Genus III.—Dasydytes (*Gosse*).

Head distinct: posterior extremely simple, truncate; body furnished with hair.

Sp. 8. D. goniathrix (*Gosse*). (Pl. ii. Figs. 9—12.) Hairs long, each hair bent with an abrupt angle; neck much constricted.

This and the following species I briefly defined, and formed of them the genus *Dasydytes*, in the *Annals of Natural History*, for Sept. 1851. The present very remarkable form was obtained from a pool at Leamington, in July of the preceding year. The length of the body is 1-150th of an inch; measured to the tips of the bristles, 1-110th. The head is nearly circular, as wide as the body, without lobes, but abruptly separated from a slender neck. The mouth takes the form of a *permanently* projecting truncate lip, or short tube. The body is rather slender, swelling toward the hinder part, and tapering to a rounded or truncate point, without any trace of the ordinary forked foot. A most peculiar and bizarre character is imparted to the creature by its clothing of very long bristles, set along each side of the back, pointing obliquely backward, but apparently wanting along the mesial line, which rises into a ridge. Each bristle is bent near its tip at an abrupt angle (see Fig. 12), so that it looks as if it had been broken and mended. The front of the head is furnished with long delicate hairs, not geniculate, which form two pencils directed backward, one falling on each side. Strong and conspicuous vortical currents were produced on each side of the head, like those of the true Rotifera (Fig. 9), and in one specimen I distinctly saw that they were caused by these frontal pencils of hairs, and that these were very long vibratory cilia. The ventral surface is set with short fine hair, which becomes longer behind (Fig. 10); doubtless cilia of unusual development, for they produced strong longitudinal backward currents, continued from the frontal vortices.

The tube of the œsophagus is always distinct, but the walls are to be discerned only when the animal is flattened by the compressorium. Then it is seen to be fusiform, instead of cylindrical, extending through one-third of the body, where its tube enters a wide cylindrical intestine, with a broad abruptly truncate anterior extremity; of this a short portion is clear, when the remainder is occupied with opaque granular food, and possibly may represent a pancreatic gland of abnormal form, as it embraces the hinder part of the gullet tube, or else is perforate with a similar tube (see Fig. 9). But in one specimen this very portion was intensely opaque, while the intestine was granular. The cloacal orifice seems to be at the very extremity of the body, as no termination of the intestine, nor even any diminution of its diameter, can be discerned short of that point. On repeated occasions I have seen the act of defecation, in one of which an oval clear corpuscle was dis-

charged, which, before, as it lay near the extremity of the body, had much puzzled me: it was probably the undissolved envelope of a minute animalcule, which had been devoured.

In one specimen, a large very clear viscus of irregular form occupied the widest part of the body, above the intestine, elevating the back into a hump. After some hours this viscus, which at first appeared structureless, developed an egg-cell with its nucleus, thus proving to be the ovary. The entire animal is of a pale smoky colour. It does not crawl like the Chætonotes, but habitually swims swiftly about, keeping, however, near the bottom of the water.

Fig. 11 represents an individual as it appeared after it had become sluggish, and apparently dying; it is evidently a view lengthwise along the back, the lower part, or that next the observer, being, I believe, the head. It is valuable as showing the arrangement of the angled hairs.

Sp. 9. D. antenniger (*Gosse*). (Pl. ii. Figs. 13, 14.) Hairs short, downy; a pencil of long hairs at each angle of the posterior extremity; head furnished with two club-shaped organs resembling antennæ. The horse-pond on Hampstead Heath yielded me this species, in August, 1850. It is a little smaller than the preceding, the length being only 1-170th of an inch; but measured to the tips of the hairs, 1-140th. In general figure, and in some particulars of its organization, it appears to diverge less from *Chætonotus*, than the preceding species does. The head is round, as wide as the body; and there is but little constriction at the neck. The upper surface is covered with short but dense hair pointing backwards, and apparently set in quincunx; the posterior extremity is somewhat three-lobed, the middle lobe furnished with a terminal brush of diverging hairs, the outer lobes each bearing a pencil of much longer hairs proceeding from its exterior side, and approaching or crossing the opposite pencil at the tips (Fig. 14). From the front of the head projects the prominent tubular mouth; on each side of which long hairs fall backward as in *D. goniathrix*, and these, by their vibration, cause a perfect vortex on each side (see Fig. 13), while there is an accessory current also down along the side, and probably all along the belly. But the most remarkable feature in this species is the presence of a pair of antennæ or tentacles; these are nearly as long as the width of the body, are slightly clubbed, and are placed one on each side of the tubular mouth, whence they spring in a curve forwards and outwards. Near the middle of the head is a little rounded mass, somewhat curdled in appearance, which I take to be a cerebral ganglion. An unusually wide and long œsophagus, ventricose behind and permeated by a tube through its centre, leads from the mouth

to a nearly cylindrical intestine. This widens a little in front to embrace the bulbous end of the œsophagus, and extends nearly to the posterior extremity. It was filled with food of a rich uniform green hue, and contained many air-bubbles, especially towards its fore part. On each side of the fore part of this viscus, I could indistinctly trace a lengthened slender body, apparently a tortuous vessel, which on one side seemed to be connected with a small oval clear organ. From the fact that sometimes it was quite plain, while at others I could not discern any trace of it, it may probably have been a contractile vesicle. The whole outline of the animal appeared to have a wavy or notched character, indicating a tuberculous surface, as in *C. Slackiæ*, if it was not an optical illusion, and caused by the hairs.

This little animal was very active, swimming with much rapidity, and rarely becoming still; when confined in cells formed by wool-fibres it was most persevering and often successful in forcing the barriers, by getting its thin flat head under a fibre, and pushing until it forced its body through also.

Genus IV.—Turbanella (*Schulze*).

Head distinct, surrounded by a ring of cilia; body naked above, clothed with cilia beneath; two rows of bristled processes along each side; posterior extremity a broad flat plate with a central division.

Sp. 10. T. hyalina (*Schulze*). (Pl. ii. Fig. 15.) Length 1-60th to 1-48th of an inch; width 1-480th to 1-360th. The body is lengthened, somewhat flat, transparent, colourless; separated by a strangulation from a rondo-triangular head, which is wholly covered with fine cilia, and bears besides a wreath of strong cilia around its centre. The hinder extremity expands into two hard flat plates, which are indented comb-like on their edge, and are divided in the middle by a sinus, into which opens the cloaca. At nearly regular distances, all along each side of the body, are placed stiff processes of the skin, to the number of twenty to twenty-five, projecting at right angles horizontally; and above these another row, consisting of six or eight similar processes, inclined backward, making from fifty to seventy in the four rows. Each process bears at its tip an excessively fine immoveable seta of about its own length. These processes as well as the skin itself were found to be quite soluble in potass, and therefore are not composed of *chitine*.

The alimentary canal runs in a straight line through the whole length. The mouth, opening on the rounded front of the head, and surrounded by a finely-plaited and indented edge, leads into the usual œsophagus with very thick transparent

muscular walls, which terminates at about one-fourth of the body-length. The perforation is so slender as to be detected only while a morsel is in the act of being swallowed. The intestine presents nothing remarkable, except that in its yellowish granular wall containing fat-cells, Dr. Schulze thinks he finds a hepatic function. The body-cavity is occupied by a finely-granular, soft parenchyma, the corpuscles scattered in which are not driven to and fro by the movement of the body, in which therefore a somewhat firm consistence is inferred. No trace of a muscular, nervous, or vascular system was discovered, though many individuals were carefully examined.

The animal is hermaphrodite. A great ovary lies in the posterior half of the body, over the intestine, in the hinder portion of which are contained the incipient egg-germs, consisting of vesicle and speck, which are developed in the anterior portion, becoming surrounded with a granular yelk. Generally one or two eggs are found freed from the ovary, enclosed in a special soft colourless envelope. In front of these mature ova lies the spermatic gland, a mulberry-like mass of cells, and close to it two groups of spermatozoid germ-cells, apparently unenclosed, lying free in the parenchyma. In some examples the spermatozoids were developed, but showed no spontaneous motion.

The specimens described occurred to Dr. Max Schulze in sea-sand from Cuxhaven, with *Desmideæ* and *Diatomaceæ*. They swam with a gentle gliding movement, like the *Turbellaria.*

Genus V.—Echinodera (*Dujardin*).

Body articulated; set with few bristles; head distinct; posterior extremity truncate, with two short processes, and spines.

Sp. 11. E. Dujardini (*Gosse*). (Pl. ii. Fig. 16.) As the discoverer and describer has not assigned any specific name to his animal, I take the liberty of honouring it with his own. M. Dujardin obtained the form in July, 1841, in sea-water from St. Malo, which had been kept for six months. The generic name, signifying "spinous neck," he selected to show its relations with *Echinorhynchus*. The body, 0·30 mm. to 0·55 mm. (about 1-75th to 1-50th of an inch) long, is oblong, almost cylindrical in front, a little flattened behind, where it terminates by two great bristles, accompanied by two other bristles of smaller size, like those we see at the extremity of the *Cyclopidæ*. The body is composed of ten segments, without counting the head, which is retractile, bristled with long and flexible spines, and without counting the caudal laminæ (*lames*) which accompany the terminal setæ, making the total number of seg-

ments twelve. The first segment of the body is united to the second by a simple intersection; all the rest are separated by a horny arch very distinct, presenting three articulations on the plane or ventral face, viz., one answering to the axis, and two lateral, between the edge and the middle. Each segment encloses the next, and appears laterally armed with two points or spines imbedded in the rear. It is covered, or simply bordered with cilia, extremely fine, not vibratile, and very difficult to perceive.

Under the first or the second segment, according to the state of retraction of the trunk, we perceive in the interior two red oculiform specks, which pertain to the retractile and protractile portion of the digestive apparatus. To the extremity of this retractile portion extends the œsophagus, longitudinally plaited in the interior, and furnished in front with a coronet of lobes, or teeth, which represent the mouth. The membranous and plaited tube of the œsophagus is covered by a thick muscular layer (*couche*), forming a cylinder 0·035 mm. wide, and 0·092 mm. long, which occupies the 3rd, 4th, and 5th segments of the body, and which, swollen in the middle, takes the form of the pharyngeal bulb of some worms. The stomach, which succeeds, is cylindrical, 0·040 mm. wide, 0·17 mm. long, and contracts itself from the front backward by successive waves: it is invested with a brownish floccose layer, which appears to represent a liver. Finally, a slenderer portion of the intestine occupies the tenth segment, and terminates between the two caudal plates.

M. Dujardin has since found it, on repeated occasions, in sea-water, on oyster shells, etc., always with the same form and characters, without ova or genital organs. "If I had not seen it," he remarks, "always alike in vessels preserved more than a year, I might have supposed it the larva of some animal that had escaped my researches. Incomplete, however, as are my observations, after having vainly sought to add to them through ten years, I believe that they suffice to show a type differing from those of the Helminthes acanthocéphales, the Systolides or Rotifera, the Entomostraca Copepoda, and the Sipuncles, and at the same time offering points of resemblance to each of these. It is a sort of *Copepode*, without feet, with the mouth of a *Sipunculus*, and the neck of a *Echinorhynchus*, and a muscular œsophagus like those of the Systolides (Rotifera), the Tardigrades, and the Nematoid Helminthes."

Genus VI.—Taphrocampa (*Gosse*).

Body articulate, destitute of hair; posterior extremity forked; mouth a mastax, with mallei and incus, which are incurved.

Sp. 12. T. annulosa (*Gosse*). (Pl. i, Figs. 17—19.) This species and genus I defined in the *Annals of Nat. Hist.* for Sept. 1851, collocating it with the *Notommatæ* and *Furculariæ*, but indicating its relations with *Chætonotus*. It occurred to my researches in a pool near Leamington, in July, 1850. Its length is about 1-110th of an inch. The form is very larva-like; the body is sub-cylindrical or fusiform, terminating in a bifid foot; it consists of many rings or segments, which are set within the clear cylindrical integument, and are themselves of a sub-square form, with projecting angles. Thus a transverse segment would present the appearance of Fig. 19;—a structure not easily explained. I could see no appearance of vortices, nor even the vibration of cilia; yet the form of the mastax is Rotiferous, and appears closely to resemble that of *Furcularia gracilis* and of the *Monocercæ*, consisting of an incus, with a long fulcrum and a pair of long incurved mallei. The animal can bring the tips of the jaws to the front, and nibbles extraneous matters with them like the *Notommatæ*, etc. A long, wide, straight, cylindrical alimentary canal, without any accessary glands or constriction, leads from the mastax to the cloaca just above the forked foot. It was in this specimen nearly empty, slightly tinged with yellow. All the rest of the animal was colourless. No eggs or ovary were visible. At the occiput, behind the mastax, was an opake mass, which was white by reflected light, but showed no redness or appearance of eye, by either reflected or transmitted light. Like the cerebral ganglion in many *Notommatæ*, it lay at the bottom of a wide deep sac (Fig. 18). The animal contracts strongly and continually like *Notommata;* but the sphere of the contraction is the space occupied by the alimentary canal, the parts outside the boundary lines of this remaining still, while the parts within retract forcibly, and both ways, but chiefly from behind forwards. In its movements it resembles *Chætonotus*, crawling sluggishly about the glass and the particles of sediment. I never saw it attempt to swim.

The number of genera has thus been increased, since Dr. Schulze wrote his summary of the family, from four to six, and of species from seven to twelve. With these augmented materials it seems to me that the judgment expressed by him as to their affinities must be somewhat modified, and I have no hesitation in recurring to the original decision of Ehrenberg, and in placing the *Chætonotidæ* among the Rotifera. Tortuous canals and a contractile vesicle I have seen in *C. larus*, *C. Slackiæ*, and *Das. antenniger:* pancreatic (?) glands in *C. Slackiæ;* ciliary vortices are made by *D. goniathrix* and *D. antenniger*, not to be distinguished from those made by many Rotifera, as *Furcularia*, *Notommata*, etc. The egg-develop-

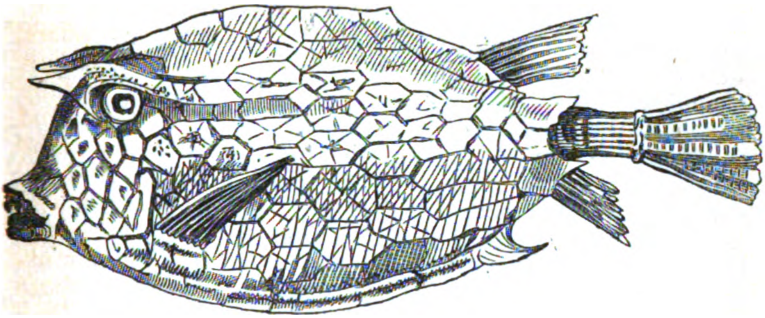
ment, the great size of the egg, and its chitinous shell, are decidedly Rotiferous.* A great cerebral ganglion, exactly corresponding to that of *Notommata aurita*, *N. tripus*, and others, is found in *Taphrocampa*, and indistinctly in *D. antenniger*. The mastax, so eminently characteristic of Rotifera, is fully developed in *Taphrocampa*, where, however, the form and extent of the alimentary canal are as in *Chætonotus*. The furcate posterior extremity is not a tail but a foot, as in Rotifera, the cloaca opening on its dorsal side; it is not indeed separately moveable even in *Taphrocampa*, yet its homology with the foot of *Notommata* cannot be overlooked; it is wanting in *Turbanella*, *Echinodera*, and *Dasydytes*; so it is in those true Rotifera, *Asplanchna* and *Anuræa*. The very long attenuate hairs that radiate from the face in several (perhaps in all) of the *Chætonoti*, which have a singular power of independent vibration, recal the very similar vibratile setæ of *Floscularia* and *Stephanoceros*; and possibly the little hooked organs which I find on the front of *C. maximus*, and the club-shaped horns of *D. antenniger*, may have a parallel in the frontal hooks of *Melicerta*.

In short, if *Taphrocampa* has a true affinity with *Chætonotus*, there can be no question that the family belongs to the Rotifera. It is true there are important diversities between these genera, but there are forms which bridge the hiatus. *Echinodera* seems to approach closely to *Taphrocampa*, but *Echinodera* has much in common with *Dasydytes*. *Turbanella* is very peculiar, yet I doubt not Schulze is right in allying it with *Chætonotus*. It is, doubtless, a group whose members manifest great diversity; but probably there remain many forms to be discovered which will further facilitate transition from one to another, and illustrate its exterior relations.

In the cilia-ring on the head of *Turbanella* in its curious setiferous lateral processes, in the form of its head, in the annulation of *Echinodera* and *Taphrocampa*, and in the long hairs of *Dasydytes*, especially the terminal tufts of *D. antenniger*,† there seem to be some strong points of alliance with Annelida, and I am inclined to place the family on the border-ground between these two great classes, the Rotifera and the Annelida, with a preponderance of characters belonging to the former.

* The relative position of the reproductive and the digestive organs is, however, contrary to that which obtains in the Rotifera; in which the latter are dorsal the former ventral.

† I beg to refer, for descriptions and figures of the young forms of some marine Annelida, to my *Tenby*, p. 279, and Pl. xv.



THE FOUR-HORNED TRUNK FISH: A NATIVE OF ENGLAND.

BY JONATHAN COUCH, F.L.S., ETC.

It was formerly believed that the fishes of this remarkable genus were to be met with only in the far East, or, at least, nowhere except in very warm climates; and although when voyages had become frequent along the coasts of Africa and India several species became known to the observers of Nature, they were for a long time regarded only as strange freaks of Nature, which might add a new interest to the cabinets of the curious, but of which the habits and distribution over the globe could be only a little studied. There were indeed a few particulars about them in which naturalists who were not travellers were fortunate; for with only a little care they might be conveyed home without distortion of shape; which was far from being the case generally with numerous fishes of other classes that were imported into England from the same regions—illustrations of which may be seen in the representations of the fishes of Amboina in the work of Ruysch, entitled *Theatrum omnium Animalium*; and there is even reason to believe that the distortions inflicted on some were made designedly, for the purpose of rendering what was strange and remarkable, still more hideous or curious.

Jonston published his *Natural History of Fishes and Whales* in the year 1649, and in it, under the name of *Piscis triangularis*, he has given a figure of two species (Plate 45); but there is no reference to either of them in his text. It is one of these, however, to which I would call the attention of British naturalists, as laying claim to be regarded as a lately-discovered, and, of course, rare visitor to our own shores—the evidence of which will be presently adduced, but concerning

which Willoughby appears to be as much at a loss as Jonston; for although he gives a good figure of it in his Plate I. 14, under the name of *Piscis triangularis cornutus Elusii*, he sums up all he knows of its history in saying, that there was an example in the Museum of the Royal Society. Linnæus appears to notice the same fish under the name of *Ostracion quadricornis*; but even in his day he supposes the whole genus to be confined to the seas of India. And that any of them should be found in Europe was not expected, until the researches of Risso led naturalists to understand that a few examples which belonged to two species had come within his notice in the neighbourhood of Nice. These are, *Ostracion cubicus*, Lin., and *O. trigonus*, Lin.; and this writer assures us of the certainty of what he relates concerning them, although he appears to have been prepared for the incredulity with which his statement would be received by many naturalists. A third species seems to be hinted at by Dr. Gulia in his *Tentamen Ichthyologiæ Melitensis* (p. 40 of the *Discorso sulla Ittiologia*); but as no description is given, and it had not come under his own inspection, we are not at liberty to refer it to the species presently to be described. But the question is of no small interest concerning the authority on which we claim for our own the example, of which we give a figure taken from the specimen; and to this the reply is short and precise. The first intimation of the alleged fact of the capture on our coast of an example of the four-horned trunk fish, was received from Robèrt Lakes, Esq., of St. Austle—himself a well-known naturalist, although chiefly in the department of ornithology—and as regards veracity he is beyond a doubt. So curious a fact as the taking this fish on the coast of Cornwall, could not fail to lead to further inquiry; in reply to which, the fish itself was sent, with the information that it had been obtained from a fisherman of Mevagissey, on the south coast of Cornwall, and that this man affirmed he had taken it in a net at some rather considerable distance from land; and, it was added, that this fisherman was considered to be of sufficient credit to warrant the belief that the information he gave might be relied on. It appears certain that this individual could not have been influenced by any motives of gain in the information he gave about this fish, for the remuneration given him was slight, if, indeed, he received any reward whatever. It was elicited also, on further inquiry, that a fish exactly similar had been taken about two years before this by a man of the same place.

The character of this genus of fishes is, that the head and body are covered with regularly-formed bony plates, which are united together in such a manner as to form a crust or unbending shell like a coat of armour, from which structure they

derive their name; and the only moveable parts are the mouth and lips, a slight border to the slit which constitutes the opening of the gills, the fins, and tail with its base or joint. There are real teeth in the jaws; dorsal and anal fins single and far behind, but no ventrals. As the firmness of the crust does not allow of motion in the body, the flexibility of the joints of the back-bone is unnecessary, and therefore they are united into one.

The length of the specimen is ten inches, of which the crust measures seven inches and seven-eighths; the height three inches and three-eights where deepest. The head slopes suddenly from the eyes. The general form compressed, sharp along the back, flat and wide on the belly; the section of the shape, therefore, triangular. Eyes, in front, elevated; and above each a prominent ridge, from which projects forward in a slight curve a stout spine—the pair resembling horns. The snout projects a little, mouth small, lips covering a row of conical teeth—the upper row eight, below six, as far as they can be counted. Gill openings, a perpendicular slit. The back rises in a ridge from between the eyes, and slopes down again toward the dorsal fin; and about an inch and a half before this fin is a small elevation—the fin itself narrow at the root, but extended. Anal fin further back, nearer the tail than the dorsal. A prominent spine posteriorly on each margin of the flattened under-surface, from which the thin border rises to the place where the moveable caudal portion protrudes from the case in a straight rudder, ending in a caudal fin—the ends of which in this example are injured. The head and body are covered with hexagonal plates, marked in lines round a raised centre. The pectoral fin narrow. Colour, yellowish-brown, but obviously faded.

1. Fontinalis antipyretica (nat. size).—2. Stem-leaf.—3. Fruit.—4. Perichætial Leaf (mag.)

THE SIDE-FRUITING MOSSES.

BY M. G. CAMPBELL.

(*With an Illustration.*)

Hitherto we have treated only of the Acrocarpous, or terminal-fruiting mosses, and though we have, from want of space, left unnoticed many of the most beautiful of that section, as the *Bryums, Muiums, Sphagnums,* etc., some of which we may describe hereafter, we purpose to devote this paper to the *Pleurocarpi,* or side-fruiters, and of these, the three Fontinaleæ, or water-mosses, fruiting in June and July, have a fructification eminently microscopic: indeed, so buried is the fruit within the leaves of the perichætium, which, like a large imbricated, persistent calyx, conceals, and appears almost to smother, the little seed-bearing urn which nestles within it, that any one unfurnished with a tolerable lens might well be excused for pronouncing them barren, even when rich, as they frequently are, at the lower part of the elder stems, with little branchlets bearing numerous immersed capsules.

The Fontinaleæ are pleurocarpous perennial mosses, growing

in water, chiefly in rivulets, where their rooting base attaches itself to stones or stumps of trees, and the rest, *i. e.*, the stem and branches, float hither and thither with the stream, like so much vegetating hair; being weak, flexible, and somewhat fragile, and the lower part of the stem being nude, or almost nude of leaves; the cellular tissue apparently absorbed in the vascular to strengthen the lower part of the stem and the fibres of the root, by which it holds its place upon whatever object they have grasped. They bear a dioicous inflorescence with lateral flowers inserted among the leaves, but neither they nor the branches are strictly axillary in Fontinalis as in most other mosses, but are inserted a little higher up than the axillæ of the leaves, and sometimes even at the side of the next leaf above. And here we do not think we can do better than quote a passage from Mr. Wilson; he says :—

"During the development of the fruit, the gemmiform flower is enlarged and elongated, and becomes a perichætial branch, the perichætium being composed of about four spires of imbricated leaves, distinguished from the stem leaves by their larger dimensions and more firm texture, closely applied to the young capsule and torn to shreds as it swells to its full size; they are inserted so high up that the vaginula in this genus seems to be almost wanting as a distinct organ, the upper part of the ramulus serving that office. The curious and extremely beautiful peristome should be examined in a recent state, before the lid is fallen away, in order to see it in perfection. If fine transverse sections of the somewhat unripe fruit are placed under the microscope, the structure of the peristome will be most advantageously exhibited, and its exquisite symmetry will much interest the observer."

We have preferred thus giving the words of another, lest our own should be accused of enthusiasm. The genus derives its name from its aquatic nature.

Fontinalis antipyretica, or the *greater water-moss*, of which we give an illustration, with the fruit, and a stem-leaf, and perichætial leaf magnified, is the frequent inhabitant of our ponds and streams, with stems a foot long or more, and much subdivided, alike carpeting the home of stagnant waters, waving in the mountain streamlet, covering the stones in artificial waterfalls, or dancing in the mill-race; in fine, growing wherever a stone is submersed in pond or lake, and there becoming the abode and the sustenance of numerous paludinæ, etc. The leaves are widely ovate, acuminate, or ovate lanceolate, sharply keeled, almost doubled, or complicate, and with the peculiarity of having all the leaves of the same branch with the margins reflexed on the same side, whether right or left, the other margin being plain. They often split down the

middle along the keel, and then the half leaves look like the whole leaves of the next species, *F. squamosa.* They are of a yellowish-green when young; olive or lurid green when old; entire or obscurely denticulate at the apex, placed in a trifarious manner upon the stem, and nerveless. The perichætial leaves, as will be seen in the illustration, are obtuse and jagged at the apex.* The capsules are sparingly produced, except on the lower part of the older branches, where they are numerous, each one immersed in its closely-sheathing perichætium, and having the lid alone protruded, till it falls off, when the blood-red peristome appears like a minute circlet, fringing the tip of the little oval bundle formed by the capsule and perichætial envelope. The peristome is double, the outer one consisting of sixteen equidistant, linear-subulate, very long teeth, much trabeculated internally, and cohering at the apex in pairs; the pairs tortuous and incurved when dry, erect below and spreading in the upper half when moist; the inner peristome is a beautifully tesselated cone, coloured like the outer teeth, with sixteen salient angles and the same number of vertical filiform cilia, united together by numerous horizontal cross-bars, and "elegantly studded internally with projecting spurs," the remains of the fractured cellules whose rupture has set it free. The lid is narrowly conical, acute, half as long as the capsule, and wears a calyptra of nearly the same size and shape. The spores are small and greenish.

The name *antipyretica* was given to this species by Linnæus in allusion to its being employed by the Swedes as an "insurance against fire;" for the moss possessing the peculiar property of not being inflammable, they fill up with it the spaces between the chimney and the walls of their houses, by which the both exclude the air and guard against accidents by fire.

There are two varieties of this moss, the one we figure was culled from Longfords Lake, near Avening, in Gloucestershire, in the year 1857. Its stems are red and shining, showing between and through the leaves, their graceful curvatures making the leaves appear somewhat distant. In that lake two varieties grew, as it were, side by side, one more robust, the other more slender, with less complicated leaves, and with fasciculated, not spreading branches.

Fontinalis squamosa, or the *Alpine water-moss*, has still shorter stems, with more crowded, slender, fasciculated branches, and crowded leaves of a dark lurid green, which are

* To the twinkling, twitching movement in the particles of chlorophyll in the cellules of *F. antipyretica*, allusion is made in the May number of this journal, at p. 271. The same molecular motion is often very conspicuous, under the microscope, in the foliage of water, or moisture-loving plants especially, as the *Sphagni*, *Jungermanniæ*, etc., inhabitants of wet and marshy places.

rounded, not keeled at the back as in *antipyretica*, concave and erecto-patent, glossy when dry, lanceolate, or ovate-lanceolate, only half as wide as in the preceding species, nerveless, and entire, but the margin never reflexed, while the perichætial leaves are also narrower, and subserrulate at the apex. The capsule and peristome bear considerable resemblance to those of *F. antipyretica*, from which, however, the plant may always be distinguished by its smaller and concave, not carinate leaves of a lurid green, its more slender stems, and more numerous fasciculate branches. It inhabits mountain rivulets, but is not generally found bearing fruit.

The *bristly water-moss*, *Dichelyma capillaceum*, is also an inhabitant of Alpine rivulets, but very rarely met with, its only undoubted European haunt seeming to be the province of Westermann, in Sweden, though it was once supposed to have visited Loch Awe. In British North America Mr. Drummond is said to have encountered it in abundance, and we give a brief description of it in hopes that some enterprising Scottish tourist may immortalize his name by drawing it forth from the custody of some Highland loch or streamlet, where its slender stems may be hidden by the multitude of other organisms that are striving for existence within its waters.

Dichelyma, named from *διχαω*, *to divide*, or *be divided into two parts*, and *ἔλυμος*, *an envelope* or *covering*, in allusion to the calyptra being cloven, has slender, rather rigid and brittle stems, varying from three to six inches in length, the branches few and widely spreading, either secund or stretching in two directions; with leaves more or less crowded, slightly falcate, erecto-patent, secund, subulato-setaceous, carinate, of a dull green, but glossy when dry, the nerve much excurrent, and forming the upper attenuated portion of the leaf, which never becomes flaccid, scarcely alters in drying, and in allusion to which the term *capillaceum*, or *bristly*, is applied to this species. The areolæ are narrow and elongated, the perichætial leaves very long, convolute, nerveless, and overtop the capsule, which is pedicellate, of thin texture, and shortly oval form, with a wide mouth destitute of annulus, and a conical or rostellate lid, which is large in proportion to the capsule; the peristome also is large, the outer teeth of a tawny red, granulated, almost linear, perforated along the medial line with from twelve to fifteen articulations, but fragile and fugacious; the inner peristome is composed of sixteen still narrower articulated cilia, perforated like the teeth, which however they exceed in length, have from fifteen to twenty joints, are marked with a medial line, papillose, of an orange-red colour, and free except at the summit, where they are united by a few cross-bars. The spores are small, and the inflorescence is dioicous.

We now turn to

THE HYPNA, OR FEATHER-MOSSES,

a genus so abundant in our isles that, according to some authors, they compose one-fifth of our whole vegetation. They have a lateral fructification, with cernuous curved capsules on long fruit-stalks, bearing a dimidiate calyptra, and having a double peristome; the outer of sixteen equidistant, lanceolate-acuminate teeth, trabeculated on the inner side, reddish-brown or yellowish; the inner peristome is formed of a membrane divided half way down into sixteen carinate processes alternating with the outer teeth, and having intermediate cilia, which are sometimes solitary, sometimes two or three together. The lid is conical, and more or less obliquely rostrate from a hemispherical base.

The species are all perennial, and grow in almost every kind of locality; but vary much in size, in habit, in the mode of vegetation, the form of their leaves, and the position of their flowers. The generic name is derived from ὕπνος, *sleep,* which tells of the use formerly made of it; and even now, a pillow stuffed with dried hypnums is by some thought to promote sleep as much as a pillow of hops. They ripen their capsules chiefly in the winter months; but some come to perfection in the spring, and several during the summer. As space would utterly fail us to notice half the members of this extensive genus, we will restrict ourselves to briefly describing those which fruit during July and August, and making a few remarks upon some others of which we may have anything new to relate, either as to locality, season of fruiting, etc., etc.

Hypnum delicatulum, then, the *delicate feather-moss,* fruiting in July and August, has a pinnatified stem, erect or decumbent, clothed with branched villi, or little green jagged processes, which cover the stem among the leaves, which leaves, in this species, are of a yellowish green, cordate acuminate, somewhat plicate, reflexed in the margin, minutely toothed in the apex, below which the rather broad nerve ceases, beautifully muricated with little sharp prominences all over the back, and even crested with them on the keel. It gives off short attenuated branches, which are often recurved and taking root at the extremity. The perichætial leaves are entire, not fringed, pale, erect, and lanceolate. The fruit-stalk is smooth, of a pale reddish colour, and an inch or more in length; the capsule oblong, curved, of a pale brown, with a conical-acuminate lid half as long as the capsule, and covered by a yellowish calyptra. Its habitats are limestone rocks and chalk hills. We have met with it, in company with *H. tamariscinum,* on the Cotteswold range in Gloucestershire.

This moss has often been confounded with *H. tamariscinum*, but its foliage is of a much paler hue, more closely muricated, more acutely pointed, the capsules of a pale brown instead of purplish red as in *tamariscinum*, and the lid short; whereas in *tamariscinum* it is rostrate, with a long beak. The aspect and season of fruiting, too, are different; *H. tamariscinum* being proliferous with innovations, the lower parts of which, as well as of the stem, are bare of branches, and it ripens its capsules in November.

The ostrich-plume feather-moss, Hypnum Crista-Castrensis, is a large and handsome species, fruiting in July and August, and producing stems from three to four inches in length, closely pectinated with crowded branches, about half an inch long, and slightly recurved. The foliage is yellowish and glossy, the stem-leaves are ovate acuminate, and circinnato-secund; those of the branches lanceolate-acuminate, still more circinnate, distinctly plicate, and having a recurved margin and serrulated apex. The perichætial leaves are erect, but striated. The capsule is of a reddish brown, curved and cernuous, on a fruit-stalk of more than an inch in length, and having a conical pointed lid.

This beautiful moss is a lover of mountainous districts; and, though rare with us, is abundant in the fir forests of Switzerland; it is also found plentifully in some localities in Scotland, near Loch Awe, in Argyleshire; and Ben Voirlich, Hill of Kinnoul, near Perth, Ben Lawers, etc., have been given as its localities, and we have ourselves most unexpectedly met with it on several parts of the Cotteswold range of hills in Gloucestershire.

Another inhabitant of the mountain, where its shining yellow flakes adorn the inclined faces of shady rocks, is the elegant little *Hypnum demissum*, or *prostrate rock-feather-moss*, extensively spreading its prostrate filiform stems, which are weak and flaccid, and all stretch out in one direction without interlacement, and bearing but few branches, which are short, slender, and of a reddish colour. The leaves are elliptic-lanceolate, entire, with a reflexed margin, loosely imbricated, slightly spreading, somewhat secund upwards, and with narrow elongated areolæ. The perichætial leaves are erect and lanceolate; the very slender fruit-stalk is smooth, reddish, and about half an inch in length, bearing the small, horizontally cernuous, pale brown capsule, whose lid has a long slender beak; and the capsule becomes contracted beneath the mouth in drying. Cromagloun Mountain, near the Upper Lake of Killarney, and near Glengariff, Ireland, also near Beddgelert, North Wales, are given as its habitats.

A fruiter in June and July is *Hypnum incurvatum*, or the

incurved feather-moss, which grows in darkish green patches on walls and stones in shady situations, chiefly in limestone districts. It has creeping stems, more or less pinnatified, with depressed branches, which however curve upwards at the top, and the leaves all bend upwards. They are ovate-lanceolate, acuminate, entire, and two-nerved at the base; the capsule is shortly ovate, cernuous, rather small, with a distinct annulus, and a short, acutely-conical lid. The inflorescence is monoicous, and the inner peristome furnished with cilia.

Hypnum pulchellum, the *neat mountain feather-moss,* or, as its distinctive scientific appellation signifies, the *little beauty,* has also a monoicous inflorescence, and ripens its capsules in June and July. It may be found on shady rocks in hilly districts, and at the roots of trees by rivulets, where its tiny branches, scarcely half an inch long, usually compressed, crowded, fastigiate, and more or less erect, form dense green glossy tufts, with leaves almost distichous, or two-ranked, but rather crowded and assurgent, gradually tapering from the base to an acute point; entire and usually nerveless. The perichætial leaves are erect; the reddish fruit-stalk not an inch long, and inserted near the base of the fertile branch among the roots; its capsule oblong, curved, of a pale brown, suberect, with a short, yellowish, conical pointed lid; tapering into the fruit-stalk at the base, and contracted below the mouth when dry.

Hypnum Mühlenbeckii, Mühlenbeck's Alpine feather-moss, inhabits Alpine rocks, fruits in July, and grows in dense green tufts, which are glossy when dry, half an inch or less in height, suberect and brittle, with fasciculate drooping branches a quarter of an inch long; the leaves subcomplanate, subcordate, acuminate, evidently serrulate, of firm texture, and either nerveless, or faintly two-nerved at the base. The fruit-stalk is reddish, less than an inch long, and the capsule, which is at first yellowish, ripens into a pale brown, is oblong in form, tapering at the base, somewhat inclined, slightly curved, striated when dry, and covered with a short conical lid. The inflorescence is monoicous.

In woods, on hedge-banks, and in moist rocky places, may be found the prostrate, sparingly-branched stems of *Hypnum denticulatum,* or the *sharp flat-leaved feather-moss,* which fruits during the summer, and has subfasciculate branches arising from the base of the stem, whence also the fructification proceeds; the leaves are complanate, glossy, of a light green, obliquely ovate, acuminate, two-nerved at the base, the lower half of the margin recurved, sometimes serrulate at the apex; the fruit-stalk is about an inch long, reddish, and the capsule, more or less tinged with red, has an acutely conical, but not a

beaked lid; the outer teeth are reddish brown, and the inflorescence is monoicous.

On Ben Lawers, the favourite haunt of some of our rarer mosses, may be found fruiting in August, the rare species, *Hypnum Halleri, Haller's feather-moss.* It, too, has a creeping stem and monoicous inflorescence, but grows in dense brownish patches, with short erect branches, crowded towards the interior of the tuft, the leaves crowded and much recurved, roundish ovate, shortly acuminate, minutely denticulated, slightly reflexed at or near the basal margin, sometimes nerveless, sometimes two-nerved at the base, the areolæ oblong and uniform, somewhat larger than in *H. polymorphum,* which this species resembles in size. The fruit-stalk is above half an inch in length, with erect perichætial leaves and a curved cernuous capsule, covered by a yellow, bluntish conical lid.

Hypnum polymorphum, or the *dwarf starry feather-moss,* is one of the smaller kinds not generally distributed, but forming the minute adornment of walls, rocks, and banks in limestone districts. It was found near Edinburgh, by Dr. Greville; on declivities near the Menai quarries, by Mr. Wilson; on limestone rocks, near Castle Howard, in Yorkshire, and on the ruins of Kirkham Abbey, by Mr. Spruce; and we have repeatedly met with it, richly fruited, in various localities in Gloucestershire. It ripens its capsules in May and early in June, but we mention it here because, as far as we know, Gloucestershire has not yet been named as possessing it, though it grows, freely fruiting, in two or three places on the Cleeve Hill, about three or four miles from Cheltenham, and also in the neighbourhood of Minchinhampton, beyond Stroud.

It has a procumbent stem, with simple slender erect branches, with rather crowded spreading leaves, somewhat squarrose, but secund, cordate, or ovate-lanceolate; in some of the leaves rather suddenly, and in all much acuminated, entire and nerveless. The capsule is oblong, curved and cernuous, with a conical lid, and the inflorescence is monoicous.

Hypnum plicatum, or the *plaited feather-moss,* too, we met with on the 23rd of April, this year, on the side of a stone wall, and near its base, at the summit of Leckhampton Hill, overlooking the valley of the Severn. There was a quantity of the moss, but only one solitary capsule, and that over-ripe, so that it had lost both calyptra and lid. It has procumbent, irregularly branching stems, the branches incurved, elongated, and ascending; the stem tomentose, with short branched leafy processes; the leaves imbricated, almost appressed in the dry state, yellowish, rather glossy, ovate, much acuminated, or tapering, more or less secund, and plicate, with narrow elongated areolæ; the perichætial leaves are pale and glossy,

smooth and erect, but slightly recurved at the apex; the fruit-stalk slender, smooth, reddish, scarcely half an inch long, and bearing a small, ovate-oblong, dull reddish-brown capsule; the peristome pale yellowish, and, probably from being over-ripe, imperfect; but the presence of this one capsule is sufficient to establish the hitherto doubtful season of fruiting, which we are inclined to fix for the end of February or early in April; and the lofty head of Ben Lawers, in Perthshire, can no longer claim to be the only British nurse of the species.

On the authority of Dr. Beach, Leckhampton Hill also possesses near its summit *Cylindrothecium Montagnei*, *Montagne's cylinder-moss*, another of the pleurocarps, for which Ben Lawers is famed. And, on the same authority, *Climacium dendroides*, Hooker and Taylor's *Hypnum dendroides*, the *marsh tree-moss*, is to be found in a marsh at Puckham Scrubs, about four or five miles from Cheltenham. This species was named Climacium by Weber and Mohr, from κλίμαξ, a *stair* or *ladder*, in allusion to the barred appearance of the inner peristome; not only in its tree-like aspect, but in several other particulars it differs from the Hypnums proper.

The shrubby *Thamnium*, or *Isothecium alopecurum*, the *fox-tail frond-moss*, with its miniature tree-like form, and dendroid stem, naked below, may be found in Gloucestershire, but in vain shall we look there for the capsules, either in October, as given by Hooker, or in November, as given by Wilson, for its fruiting season; the writer, however, met with some square yards of ground at the foot of a fir-tree grove, at the head of Longfords Lake, near Avening, covered with it in luxuriant profusion, and freely fruiting, January the 21st, 1858, some specimens having twenty-five and more capsules, some of them having their oblique long-beaked lids still on, while others had dropped their lids, and were exhibiting their pale double peristome, very like that of a Hypnum, to which genus it was formerly assigned by Linnæus and others, but from which it has been very properly separated on account of striking differences.

Space will not admit of further details, but we trust that those of our readers who have followed us thus far, will be induced to enlarge the sphere of their pleasures by investigating for themselves this too-neglected department of nature's economy.

FACTS ABOUT IRON.

Antiquaries have, for the most part, decided that an "age of bronze" preceded an age of iron; but, although they may establish their theory to a certain extent, it cannot be accepted as universally or necessarily true, and it is very important, in studying the manners of ancient races, or in examining their works, to bear in mind the arguments that favour an hypothesis of a totally opposite kind. When rich ores are readily attainable, and wood to make charcoal is at hand, the most natural order of development is that iron should be smelted and employed long before the discovery of the mode of making bronze; and if any people, who might have extracted iron with facility, really began their metal working by a scientific combination of copper and tin, it would be only fair to conclude that they did so, not as a result of native development, but by the instruction and example of a more advanced race. Dr. Percy remarks,* "that of all metallurgical processes the extraction of iron is the most simple. Thus, if a lump of red or brown hematite be heated for a few hours in a charcoal fire, well surrounded by or imbedded in the fuel, it will be more or less completely reduced, so as to admit of its being forged at a red heat into a bar of iron." He adds that this primitive process requires far less skill than what is employed in the manufacture of bronze. The extraction of iron from its richer ores belongs to an antiquity transcending the historic period, and it is remarkable that it can be effected on a small scale without even the help of a furnace, in a simple apparatus rather partaking of the character of a forge. Dr. Percy cites an example of this, upon the authority of Dr. Hooker, in whose *Himalayan Journal* appears an elegant sketch of a young man standing upon a large pair of primitive bellows, which he works with his feet. A fascinating young woman stands behind him upon the same machine, and the stream of air they impel passes through the bottom of an upright, flat, sloping stone, under whose shelter glows a small fire, in which little balls of iron are produced. This sketch is copied in Dr. Percy's work.

In working on a small scale, malleable iron is obtained directly from suitable ores. This is the case in the native production of the Hindoos, the Africans, the Borneans, and all

* *Metallurgy: the art of Extracting Metals from their Ores, and adapting them to various purposes of Manufacture*, by John Percy, M.D., F.R.S., Lecturer on Metallurgy at the Royal School of Mines. Iron and Steel with Illustrations, chiefly from original drawings, carefully laid down to scale. *Murray*.

other iron-working races in an early stage of metallurgical knowledge. In the enormous works of modern times the result of smelting is to obtain cast iron, which requires separate and costly processes to bring it into the malleable state. Ultimately, however, we may expect the success of plans by which malleable iron may be obtained directly from the ore, in quantities and at prices adapted to manufacturing requirements. Those who desire to know what has been done in this direction may consult Dr. Percy's elaborate work. It is not a subject that we intend to discuss in this paper, but we cannot help remarking that iron production, under our cumbrous patent laws, has got into such a deplorable state of complexity and confusion as to indicate a necessity, both in the interest of the public and that of inventors, to reconsider our whole system of offering the alleged advantages of a monopoly to the discoverers of new processes and new plans. So far as the general public is concerned, there is little doubt that our patent laws act badly; but it is obviously unfair that inventive talent should go without its reward, and it does not coincide with ordinary ideas of justice that the anxious toil and laborious thought of many years should be seized upon by outsiders at the very moment when a reasonable prospect of remuneration appears. Thus, at first sight, patents as granted in this country seem advantageous to inventors; but it will be found that a time arrives in most important branches of manufacture in which this ceases to be the case. Let any one, for example, now turn his attention to iron, and he will find the patents already in existence surrounding him like pitfalls on every side. Schemes unsuccessful, and schemes partially successful by the hundred are found to be under the protection of the patent laws. Very often it is quite impossible to ascertain the limits to any particular patent without a series of actions and appeals, in which the longest purse is most likely to win. Thus, a fresh comer into the field buys "a pig in a poke" when he purchases a patent, and has small chance of peaceably enjoying his acquisition, unless it should prove worthless; and little hope of maintaining it against attack, unless he has a great capital at his command. We must still come back to the moral axiom that those who benefit society by their intelligence deserve reward, but we much doubt whether anything like our existing patent system is calculated to secure that desirable end.

In this country iron working was probably an ancient art, as there is evidence that it was practised anterior to Roman times. Dr. Percy cites authorities to show that it was understood by the old Egyptians—Mr. Layard found some iron work at Nineveh, and Mr. Francis Galton has recently given to

Dr. Percy a specimen of black slag, not unlike iron slag, lately found in "very ancient Sinaitic remains, conjectured to be anterior to the time of Moses."

Many of the iron ores now worked in this and other countries would not have suited the early processes, nor would they, in many cases, have disclosed their character to the imperfect science of early times; but, notwithstanding this fact, which would operate in favour of bronze in certain localities, it still remains for the antiquary to explain why nations who were acquainted with iron should have resorted to an expensive and, as we should think, imperfect substitute for a metal that we now regard as a prime necessity of civilized life.

Of all the substances which modify the character of iron, carbon is the most important, enabling it, according to circumstances and treatment, to become hard, elastic, or brittle. The mode of the existence of carbon in its compounds with iron is by no means well understood. Dr. Percy states that it is partly determined by the conditions under which the metal is heated and cooled, at temperatures very far below its melting point; and he adds that, "Professor Abel, of the Arsenal, experimented on this point a few years ago, and found that hardened steel wire dissolved in hydrochloric acid without residue; whereas the same steel in the softened state yields by such action a dark flocculent carbonaceous residue when acted upon by the same acid." Steel, in its three states known as "blistered," "tilted," and "hardened," yields a different residue or solution. It seems, on the whole, to be proved that carbon may exist in iron in the state of mechanical diffusion, and also in a state of chemical combination; but neither Percy nor any other chemist has succeeded in throwing much light upon the carbides of the metal. It is very curious that hammering should affect steel so as to change the proportion of its carbonaceous residue in acids, but "Caron found that rolled steels, *cæteris paribus*, yielded a larger amount of carbonaceous residue than hammered steels." In this case the mechanical force exerted in hammering seems to have passed into the state of a chemical force, by which the condition of the carbon was changed. Rolling, as a less disturbing action of mechanical force than hammering, produced less effect.

Dr. Percy, though fully believing in the influence of mechanical force as just described, throws some doubt on the amount of action usually ascribed to blows or vibrations in rendering iron brittle, and he is not satisfied that it induces a crystalline structure. As this question enters so largely into safety of railway travelling, it is hoped that it will receive thorough investigation. Pending this, we may remark that the

condition of iron after fracture must not be taken as necessarily showing in what state it existed before fracture occurred. Dr. Percy tells us that "when a piece of iron which has been melted, and which is largely crystalline, is cautiously hammered at a suitable temperature into a shape adapted for rolling, and then rolled into a bar, not too thick, it will present either a fibrous or a crystalline fracture, according to the manner of breaking it, and especially the duration of the act. After nicking it to a slight depth on one side with a cold chisel, and then bending it slowly backwards from the line of the nick, the fracture will be highly fibrous, and may be almost silky. On the other hand, if it be nicked all round, and suddenly broken in the line of the nick, the fracture will be crystalline, with, it may be, only here and there an indication of fibre."

We have stated that the modern processes for smelting iron on a large scale produce cast, or carburized iron, and this will be readily understood from Dr. Percy's explanations. "The furnace being in operation, or, as it is technically termed, in blast, iron-yielding materials (of which the essential part is oxide of iron), flux (generally limestone), and fuel, are continually thrown in at the top, so that the interior may be kept filled up nearly to the filling holes, while slag, or "cinder," and cast iron continually accumulate in the hearth at the bottom, the former flowing out over the dam, and the latter being allowed to escape at intervals through the tapping hole." The oxygen of the air blown in to constitute the blast forms carbonic acid with the carbon of the fuel, and this gas, passing into the state of carbonic oxide, readily reduces the oxide of iron. The ore, or iron oxide, is reduced as it descends in the furnace, and as it falls towards the lower and hottest part of the furnace the metal "becomes carbonized, and converted into cast iron, which trickles down in a molten state to the bottom." The iron not only acquires a large dose of carbon in this process, but likewise takes up all kinds of impurities that are present, and thus needs subsequent treatment to decarbonize it, and remove extraneous matters. An expensive and very laborious treatment of cast iron is resorted to in our large works for the purpose of obtaining the metal in a malleable state. This is technically called "puddling," and "consists essentially in stirring about pig-iron molten on the bed of a reverberatory furnace, heated by flame, until it becomes converted into malleable iron, through the decarbonizing action of the oxygen of the air circulating through such a furnace." One of the most remarkable inventions for decarbonizing pig-iron is that of Mr. Bessemer. The pig-iron is melted in a suitable furnace, and jets of air are then introduced. As the inventor states, "the air expanding in volume, divides itself into glo-

bules, or bursts violently upwards, carrying with it some hundred weight of the fluid metal, which again falls into the boiling mass below. Every part of the apparatus trembles under the violent agitation thus produced, a roaring flame rushes from the mouth of the vessel, and as the process advances it changes its violet colour to orange, and finally to a voluminous pure white flame. The sparks, which were at first large, like those of ordinary foundry iron, change to small hissing points, and these gradually give way to soft floating specks of bluish light as the state of malleable iron is approached."

As our object is not to write a technical paper on iron manufacture, we shall refer those who want detailed information on the various projects of the day, to Dr. Percy's work, merely citing his opinion that for the Bessemer process to be "generally applicable in this country, it must be supplemented by the discovery of a method of producing pig-iron, sensibly free from sulphur and phosphorus, with the fuel and ores which are now so extensively employed in our blast furnaces." The doctor adds, "the problem may be difficult of solution, but surely it is not a hopeless one."

In our domestic economy, broken cast-iron vessels are usually thrown away; but the Chinese not only make very thin cooking utensils of the cast metal, but dexterously mend holes and cracks.

Dr. Percy states, on the authority of Dr. Lockhart, how this is done. The Chinese tinker scrapes the surface of the broken vessel clean. He then melts a portion of cast iron in a crucible the size of a thimble in a furnace "about as large as the lower half of a common tumbler." The iron when melted is dropped on a piece of felt covered with charcoal ashes. It is pressed inside the vessel against the hole to be filled up, and as it exudes on the other side, he strikes it with a small roll of felt covered with ashes. The new iron and the old adhere, and when the superfluous metal is removed, the job is complete.

Among the miscellaneous matters of interest in Dr. Percy's book, not the least curious are those relating to the action of sea-water on cast iron, converting it at length into a grey porous mass that grows rapidly hot in contact with air. In 1740 some iron guns that went to the bottom with part of the Spanish Armada, were fished up near Mull, in Scotland. On scraping them they soon became so hot that they could not be touched, and a ship surgeon, who was applied to for an elucidation of the mystery, suggested that "as they went down in the heat of action they might not have had time to cool, though nearly 200 years had elapsed."

The alloys of iron are numerous, and special merits are

claimed for many of them. On this subject, however, much information is still wanted, and when fine steel is produced, it by no means follows that it owes its qualities to a minute portion of some other metal, or non-metallic substance conjectured to have affected it beneficially. It is of course quite possible that minute additions may produce great results; but if we may judge from Dr. Percy's book, very little has been accurately ascertained. One alloy of 80 parts zinc, 10 copper, and 10 iron, is said to possess very valuable working properties, and not to rust in moist air.

Dr. Percy also mentions Mr. Eckman's process of case-hardening by arsenic. Rasped leather, or other nitrogenous animal matter, is made into a sort of porridge with hydrochloric acid and arsenious acid. The metal is painted over with this composition about one-sixteenth of an inch thick, and then heated in a muffle to bright redness. A white surface of arsenide of iron is thus obtained, which effectually resists rust.

The bulky volume from which we have made the preceding extracts forms the second part of Dr. Percy's *Metallurgy*, and a third part is expected to complete it. The scientific world will unanimously applaud the doctor's labours. He has brought together an amazing mass of facts, which perhaps no one else had accumulated, and a large portion of which he has for the first time made accessible. He has undoubtedly achieved a great work; but the second volume, like the first, leaves the regret that his talent for exposition and arrangement is not equal to his enormous metallurgical learning. As storehouses of facts, the two volumes are invaluable, but as regards the elucidation of principles, or convenience for reference, they leave much to be desired.

THE REMARKABLE WEATHER OF THE EARLY SUMMER OF 1864, AT THE HIGHFIELD HOUSE OBSERVATORY.

BY E. J. LOWE, ESQ., F.R.A.S., ETC.

The extraordinary heat of May and the equally extraordinary cold of June makes it desirable to place on record this singular weather of 1864.

On referring back to old records we find that on Midsummer day, A.D. 1035, so vehement a frost occurred that the crops and fruit were destroyed; that on the 2nd of May, 1767, at Aldstone and Cole Fall, there was a great fall of snow and hail, the ground being covered in some places to the depth of three feet. In this year (1767), on July 13th, there were great floods in Bedfordshire and Lincolnshire; on July 4th a prodigious quantity of snow fell in Pomerania; on August 5th a great storm occurred in Roxburgh, carrying houses and bridges away; on August 12th, at Leeds, the river rose six feet in an hour, being higher than for twenty years, and destroying forty bridges; that during the month of May, on the 12th, a dreadful thunder and hail-storm passed over County Fermanagh; another on the 16th at Earlstown, Scotland, the hail being four inches in circumference, and on 31st, a third, occurring at Nottingham, Norwich, and London, accompanied by a N.W. gale. In Herefordshire there were fewer apples than for twenty years previously, and scarcely any walnuts.

In 1773, on May 6th, at Birmingham, snow fell to the depth of twelve inches, followed, from the 18th to the 27th, by the highest floods ever known in May, and which were general throughout England. Earthquakes occurring in Staffordshire and Shropshire on the 30th of June and 1st and 2nd of July.

In 1780, at Nottingham, on May 20th, a severe frost; on the 28th the temperature 75° in shade, on the 29th 81°, and on the 30th only 57°.

In 1794 the greatest heat and the greatest cold began to be recorded at the Royal Society, and in 1840 at the Royal Observatory, so that for the last seventy years we have a continuous series of observations, and from others of Dr. Dalton, Mr. Luke Howard, and Mr. Bent, the series can be extended back to 1785; and a descriptive history as early as 1752, or for 113 years, and in no instance has the temperature of the 18th and 19th May, 1864, been reached, nor the cold of June 1st, 1864.

In order to compare the observations, we will select Man-

chester (Mr. G. V. Vernon), the Royal Observatory, and Highfield House.

Comparison of the greatest heat at the Royal Observatory, the Highfield House Observatory, and at Manchester, between 1856 and 1862, in May and June:—

Year.	Royal Observatory. May.	Royal Observatory. June.	Highfield House Observatory. May.	Highfield House Observatory. June.	Manchester. May.	Manchester. June.
	°	°	°	°	°	°
1850	76·5	85·1	79·2	87·2	—	78·0
1851	74·2	87·0	77·0	85·3	75·0	—
1852	73·4	72·7	79·0	77·0	73·0	76·5
1853	78·8	81·0	82·0	82·0	77·7	79·0
1854	70·5	78·5	73·0	79·0	72·0	77·0
1855	81·5	83·5	81·9	83·3	84·0	83·5
1856	72·0	83·1	70·8	84·2	78·3	77·0
1857	80·2	92·7	72·8	88·0	77·8	90·5
1858	81·2	94·5	84·0	92·2	—	91·2
1859	77·0	81·3	78·5	80·4	82·0	81·8
1860	76·5	74·0	79·8	73·5	78·0	71·4
1861	80·2	81·8	79·8	82·8	72·2	84·0
1862	81·5	73·5	77·7	76·4	76·0	—

In the above years it will be seen that the maximum heat in May reached 81°·5 at the Royal Observatory, and 84°·0 at Highfield House and Manchester; and in June, 94°·5 at the Royal Observatory, 92°·2 at Highfield House, and 91°·2 at Manchester. In May it was warmer at Highfield House than at Manchester from 1851 to 1854, colder from 1855 to 1859, and warmer from 1860 to 1862; at the Royal Observatory it was colder from 1850 to 1855, warmer in 1856 and 1857, colder in 1858 to 1860, and warmer in 1861 and 1862.

In June it was warmer at Highfield House than at Manchester, except in the years 1855, 1857, 1859, and 1861; it was warmer at the Royal Observatory, except in 1850, 1852, 1853, 1854, 1856, 1861, and 1862.

The mean of the greatest heat of all these years being:—

Greenwich . . .	77°·2	in May, and	82°·2	in June.
Highfield House .	78·1	„	82·4	„
Manchester . . .	76·9	„	80·9	„

Highfield House being warmer than Greenwich in May by 0°·9, and in June by 0°·2, and warmer than Manchester in May by 1°·2, and in June by 1°·5.

Comparison of the greatest cold at the Royal Observatory, the Highfield House Observatory, and at Manchester, between 1850 and 1862, in May and June:—

Year.	May. Royal Observatory.	May. Highfield House.	May. Manchester.	June. Royal Obs.	June. Highfield House.	June. Manchester.
	°	°	°	°	°	°
1850	31·7	31·2	—	36·2	35·1	—
1851	33·5	31·0	36·0	38·5	38·0	—
1852	29·3	32·0	30·0	41·0	39·7	38·0
1853	32·6	30·4	30·0	39·9	37·2	40·0
1854	34·8	31·4	31·5	41·4	41·0	42·0
1855	28·3	26·8	24·0	39·3	39·8	38·5
1856	29·8	30·9	28·8	41·1	39·1	39·0
1857	31·5	30·0	30·0	38·8	40·0	43·8
1858	32·1	30·9	—	45·3	39·5	41·8
1859	33·1	30·8	30·8	43·5	41·9	44·7
1860	32·5	30·0	33·0	43·5	39·5	40·8
1861	33·4	28·7	28·0	42·9	42·5	44·0
1862	37·8	35·5	38·0	43·4	39·7	—

In these years Highfield House was colder than at the Royal Observatory in May in all years, except in 1852 and 1856; and in June, except in 1855 and 1857. Highfield House was colder than Manchester in May, except in 1852, 1853, 1855, 1856, and 1861; and in June, except in 1852, 1855, and 1856.

The mean of greatest cold in all these years gives the following result:—

Greenwich . . .	32°·3 in May, and	41°·1 in June.	
Highfield House .	30·7	,,	39·5 ,,
Manchester . . .	30·9	,,	41·3 ,,

Highfield House being colder than Greenwich in May by 1°·6, and in June by 1°·6; and colder than Manchester in May by 0°·2, and in June by 1°·8

From the Royal Society and Royal Observatory Records.

The highest readings in May, and greatest cold in May and June, with the maximum heat in June of those years:—

Year.	Greatest Heat in May.	Greatest Cold. May.	Greatest Cold. June.	Greatest Heat. June.
	°	°	°	°
1795	81·5	36·0	41·0	77·5
1807	84·0	44·0	48·0	77·0
1808	82·0	42·0	48·0	76·0
1833	81·4	43·4	46·6	80·8
1841	82·8	41·2	40·3	78·5
1846	84·3	38·3	49·4	91·1
1847	86·2	36·0	41·0	80·4
1848	83·0	33·5	38·7	78·4
1855	81·5	28·3	39·3	83·5
1857	80·2	31·5	38·8	92·7
1858	81·2	32·1	45·3	94·5
1861	80·2	33·4	42·9	81·8
1862	81·5	37·8	43·4	73·5

From 1785 to 1807, Mr. William Bent kept a register in London, during which time the thermometer never reached 80° in May, except in 1807.

Dr. Dalton's observations at Kendal only give once a temperature of 80° in May, which occurred in 1788.

My late lamented friend, Mr. Luke Howard, in his series of observations from 1797 to 1832, made at Plaistow and Tottenham, near London, gives the following:—

1806, May	29	81°
1807, „	25	85
1809, „	18	80
1811, „	26	84
1815, „	26	80
1822, „	20 and 21	81
1825, „	23	80
1829, „	23	81
1830, „	7	81

In Mr. Glaisher's valuable tables of the mean temperature of every day in the year, based on forty-three years' observations, we have—

May	1 to 8,	mean	50°·0	to	50°·9
„	4 „ 14,	„	51·3	„	51·8
„	15 „ 17,	„	52·2	„	52·8
„	18 „ 21,	„	53·1	„	53·8
„	22 „ 27,	„	54·1	„	54·9
„	28 „ 31,	„	55·2	„	56·1
June	1 „ 3,	„	56·4	„	56·8

The mean temperature of the coldest day in May was 36°·2 on the 3rd, in 1832; the mean temperature of the hottest day in May was 72°·6 on the 15th in 1833, giving a range of 36°·2 in mean temperature.

The mean temperature of the coldest day in June was 45°·0 on the 7th in 1814; the mean temperature of the hottest day in June was 76°·1 on the 13th in 1818, giving a range of 31°·1 in mean temperature.

In 1864 at Highfield House the mean temperature exceeded the average on every day up to the 22nd, except on the 4th and 9th, on the warmest days being:—

May	14	61°·5
„	15	68·8
„	16	69·2
„	17	65·1
„	18	72·9
„	19	71·2
„	20	67·2

Again—

May 26	46°·5
„ 31	47·9
June 1	49·5

Frosts occurred on	May 24,	27°·3	on grass, and	34°·9	at 4 feet
„	„ 27,	24·9	„	33·9	„
„	„ 30,	31·5	„	39·0	„
„	June 1,	23·3	„	30·5	„
„	„ 2,	23·5	„	34·3	„

The maximum heat in shade, and greatest cold, in 1864, was—

On May 14,	75°·2,	greatest cold,	40°·9
„ 15,	81·2,	„	55·7
„ 16,	82·8,	„	56·1
„ 17,	80·3,	„	49·8
„ 18,	87·7,	„	53·7
„ 19,	89·3,	„	56·2
„ 20,	80·7,	„	53·5
„ 21,	65·7,	„	50·7

At Highfield House the greatest heat of May from 1842 to 1864 has been—

1846	81°·4
1847	84·5
1848	83·0
1853	82·0
1855	81·9
1858	84·0
1864	89·3

So that our greatest heat in 1864 has exceeded every year in May by 3°·1; and, were we to carry our investigations through the months of June, July, and August, we should find very few days in these hotter months in which the temperature rose above 89°·3.

It is worthy of remark that almost invariably hot weather in May has been followed by violent atmospheric disturbances, such as thunder-storms, hail-storms, gales, and floods, and even not infrequently by earthquakes and disturbances of the sea.

Taking the thirteen hottest years in May from 1794 to 1862, as recorded by the Royal Society and Royal Observatory, it will be seen that, in eight years the temperature never rose to the same height again during the summer, whilst in 1846, 1857, and 1858 it became very hot.

As a contrast to the great heat of May, 1864, we will turn

to the great cold of the 1st of June, 1864, in the neighbourhood of Nottingham (at 4 feet elevation), viz.:—

Highfield House Observatory, greatest cold	30°·5
Beeston Observatory . . . ,,	28·5
Lenton Grove (Mr. Samuel Morley),, .	27·5
Highfield House, greatest cold on grass .	23·2
Beeston . . . ,, ,, .	23·3

This frost was much more severe in the valley a quarter of a mile from both Highfield House and Beeston, Mr. Morley's instruments being half-way between these two observatories.

The damage done at Highfield House is confined to the leaves of gourds and partial destruction of leaves of potatoes, and French and Kidney beans. At Mr. Morley's, young shoots of hollies and walnuts were killed, and more damage done to beans and potatoes. At Beeston, except in sheltered places, the potatoes and beans were cut to the ground; young shoots of ash trees killed, as well the small branches of Rose Gloire de Dijon, Polygonum Sieboldtii, Rhododendrons, and partial damage to the bloom of strawberries and the fruit of apples, pears, and gooseberries. Much greater damage was done six miles north of this place, at Basford and Bulwell, and where the thermometer must have been considerably lower. Here in every direction beans and potatoes were killed to the ground, every leaf of the walnut destroyed; nearly all the apples, pears, plums, nuts, and gooseberries, the young shoots of hollies, and even those of the English oak.

In referring to the same records of the Royal Society and Royal Observatory as examined by Mr. Glaisher, we obtain the following as the coldest years in June:—

1797 . . .	greatest cold,		40°·0
1802 . . .	,,	,,	40·0
1841 . . .	,,	,,	40·3
1848 . . .	,,	,,	38·7
1849 . . .	,,	,,	38·6
1850 . . .	,,	,,	36·2
1851 . . .	,,	,,	38·5
1853 . . .	,,	,,	39·9
1855 . . .	,,	,,	39·3
1857 . . .	,,	,,	38·8

My own observations at Highfield House giving—

1843 . . .	greatest cold,		40°·0
1848 . . .	,,	,,	40·1
1849 . . .	,,	,,	35·3
1850 . . .	,,	,,	35·1
1851 . . .	,,	,,	38·0

1852	. . .	greatest cold,	39·7
1853	. . .	,, ,,	37·2
1855	. . .	,, ,,	39·8
1856	. . .	,, ,,	39·1
1857	. . .	,, ,,	40·0
1858	. . .	,, ,,	39·5
1860	. . .	,, ,,	39·5
1862	. . .	,, ,,	39·7
1864	. . .	,, ,,	30·5

So that the temperature on the 1st of June, 1864 was 4°·6 lower than had been recorded before in June since 1797, and there is no year nearly so low, even if we go back to 1785; whilst, if we take Mr. Morley's reading of 27°·5, which is quite correct (made by an excellent thermometer of Messrs. Negretti and Zambra, compared by my Kew standard), we have 7°·6 below any other reading, and 8°·7 below the lowest reading in London.

In conclusion, a few words on the weather of May will have its bearings on the subject.

The movement of the wind from the 1st to the 21st was—

From 1st to 5th,	direct,	1260°;	retrograde, 1012°
,, 6th to 10,	,,	635;	,, 472
,, 11th to 15,	,,	1720;	,, 1384
,, 16th to 20,	,,	3275;	,, 2407

The direct exceeding the retrograde movement by 1611°, or by 4½ complete revolutions. The greatest changes occurring on the 15th; direct, 956°, retrograde 888°; on the 18th, direct 990°, retrograde 922°, and on the 20th, direct 1440°, retrograde 675.

On the 19th, a few minutes before the time of greatest heat, viz., 2·30 p.m., the thermometrical and hygrometrical conditions of the air were—

Temperature in shade	89°·0
Wet bulb thermometer	67·9
Temperature of the dew point .	53·1

Elastic force of vapour, 0·404 of an inch.

Weight of vapour in a cubic foot of air, 4·2 grains.

Additional weight of vapour required to saturate a cubic foot of air, 10·2 grains.

Degree of humidity (100 = saturation) 29.

Weight of a cubic foot of air, 508·8 grains.

Weight of the barometer reduced to the sea-level, 30·204 inches.

Pressure of the gases of the air, 29·800 inches.

Whole amount of water in a vertical column of the atmosphere, 5·6 inches.

Thunder was heard all the afternoon, and a thunderstorm occurred on the afternoon of the 20th.

On the evening of the 29th the earthquake pendulum showed a sensible movement of the earth from WNW. to ESE., and that from this time till noon on the 30th the earth was in constant gentle movement.

Rain only fell on nine days in May, the amount being only 1¼ inches, the barometer ranging between 29·7 and 30·2 inches.

From the 18th to the 20th there was scarcely any ozone, and during this period an almost cloudless sky.

MAGNUS ON THE CONDENSATION OF VAPOURS.

The *Archives des Sciences*, No. 77, and *Poggendorf's Annalen*, cxxi., p. 174, contain an account of some important researches of M. Magnus on the condensation of vapours on the surface of solid bodies, from which we extract the leading facts:—

M. Magnus begins by referring to a former paper, in which he showed that a thermo-electric pile grows warmer when moist air is brought into contact with its surface, and grows cooler under a similar contact with dry air. These effects are produced whether the surface of the instrument is blackened with smoke, or is kept bright. He considered that the elevation of temperature was due to the latent heat evolved by the vapour during condensation. Pursuing the investigation in a manner that is detailed in the publications to which we have referred, the conclusion was arrived at that all substances grew warmer when brought into contact with air more moist than that which surrounds them, and became cooler in contact with air that is more dry. In order, however, to enable this action to become sensible, the plates must not be too thick. The degree of disturbance varies with the nature of the plates employed, with the dimensions of their surfaces, and with their thickness; but the effects are universal, whether the surfaces be rough or smooth. In employing glass the strongest effect was noticed when the plates were very thin, such as are used for microscopic objects or for polarizing piles. Experiments were made with brass, glass, gypsum, mica, sal gemmi, and alum. When ungreased leather, wood, ivory, gutta percha, and certain other substances were

employed, the deviation of the galvanometer was at least as great, and sometimes greater than when the dry or moist air impinged directly on the thermo-electric pile, showing that they condense vapours more readily than the surface of the pile.

M. Magnus arranged a delicate air thermometer, so that each bulb was surrounded by a small vessel of glass, each glass vessel having a tube proceeding from its neck, immediately over the bulb. On blowing air into one of the glass vessels the thermometer was not affected; but if the air was first dried, then the opposite bulb experienced a cooling action, and became warmer when air saturated with vapour was introduced. The effect was sufficient to produce four to six millimetres difference in the level of the two limbs of the thermometer.

A mercurial thermometer divided into half degrees, and sheltered from currents of air, showed under similar circumstances an effect from 0·2 to 0·3 C.; and, when the bulb was blackened, the variation reached 0·6 C.

The rapidity of the effect depends on the thickness and condensing power of the plates. Sal gemmi and other diathermic bodies were instantaneously affected; metallic plates, etc., varied according to their conducting power.

In giving a summary of results, M. Magnus states that different substances, organic and inorganic, wax, paraffin, glass, quartz, mica, gypsum, various salts, metals rough or polished, and also varnished, condense on their surface vapour from the air in which they are placed, and whose temperature is the same as their own. This condensation has a heating action; and if drier air is introduced, a portion of the liquid that has been condensed evaporates, and cold is the result. Vapours of alcohol, ether, and other substances produced effects analogous to those of water. In general it may be affirmed that vapours are condensed on solid masses to an extent sufficient to produce appreciable changes of temperature. From this it will appear that on every solid surface a layer of vapour always exists, which becomes greater or less, according to the humidity of the air. M. Magnus adds that it cannot be doubted that this film of vapour plays an important part in many actions that occur on the surface of bodies.

SOLAR OBSERVATION.—COLOURS OF STARS.—CONSTITUTION OF NEBULÆ.—TRANSITS OF JUPITER'S SATELLITES.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

In a previous paper we enumerated several modes of eliminating the superfluous light and heat otherwise so prejudicial in examining the sun. Two very efficient ones, however, remain to be described.

One very generally applicable contrivance is a modification of the diagonal eye-piece, which has been long in use, in order to avoid the neck-twisting process of observation with an achromatic at great altitudes. For this purpose a plane speculum is introduced diagonally into the interior of the eye-piece, or preferably into the tube just beyond the eye-piece; and in the latter form, if a piece of unsilvered glass is used instead of speculum metal, it is obvious that so little light will be reflected from its anterior surface, that a very pale screen-glass will be quite sufficient. Sir J. Herschel, the inventor of this plan, employed it with a Newtonian reflector at the Cape, and Dawes applied it to the achromatic immediately afterwards. The reflection from the second surface must be got rid of, to avoid the doubling of the image. This may be effected by roughening the back, or by using a prism—a modification adopted by Cooke with his large achromatics. The end of the tube, behind the "transparent diagonal," should be open to admit of the free escape of the transmitted heat. This method is so effectual, that substituting a piece of transparent glass for the small speculum in his great Newtonian silvered reflector, Mr. Bird was able to use his 12-inch aperture for nearly an hour without inconvenience, even during the intense heat of last May.

The most remarkable apparatus, however, and that which has led hitherto to the greatest discoveries, is "Dawes's Solar Eye-piece," so named from the eminent observer who invented it. In this arrangement, a metal slide is perforated with a series of holes, varying in size from 0·5 (or 0·3, which is safer for the screens) down to 0·0075 of an inch, any one of which may be brought into the centre of the field at pleasure. The greater part of the heat is so completely intercepted by the metal, which in turn is insulated by a plate of ivory from communication with the eye-piece, that the inventor has used this simple arrangement on Lassell's great 24-inch speculum for two hours of bright sunshine without unpleasantly heating the eye-

piece.* It is, of course, intended as an auxiliary to high powers, with which the diminution of light at the same time admits of the advantage of a thin pale screen-glass. In some instances of very large spots and a favourable state of air, the whole of the luminous surface may be excluded, and the spot, under clockwork, or very careful hand motion, be studied alone. This admirable contrivance is also useful without the dark glass for examining many other celestial phenomena where the brightness of neighbouring objects has a disturbing effect. In its latest modification, the various perforations and screens are arranged on circular plates, technically known as "wheels." Lassell's suggestion, that thick paper, covered with white lead, such as is used for glazed visiting cards, forms an admirable insulator as to heat, may be turned to good account in the construction of an economical arrangement to answer the same purpose.

There is, however, a totally different mode of observation, which, if less striking, and less adapted for minute details, than direct vision, is far more easy and convenient—that of *projection;* in which the image is transmitted through an ordinary eye-piece, adjusted by trial till perfect distinctness is obtained, to a large opaque screen at a suitable distance behind it. If this screen is white, smooth, and carefully arranged at right angles to the axis of the telescope, the correct focus being also carefully determined by repeated trial, this method will give a very fair representation of the principal solar phenomena. Mr. Howlett, indeed, who makes great and successful use of it, tells us that he even gets a more perfect view in this way than by direct vision. At the same time, it has the great merit of supplying us with an accurate and inexpensive micrometer, the image of the sun being made, by proper adjustment, to coincide with a circle graduated by lines into suitable divisions; and thus the position of the spots may be measured, and their progress made evident, from day to day. Carrington, one of our best solar observers, employed this mode, projecting the image on plate-glass, coated with "distemper" of a pale straw colour. A large piece of cardboard, with a hole in the middle, to slip over the object-end of the telescope in the place of the brass cap, must be provided to throw a shade upon the screen; and the latter, if measurement is the object, must be attached to a bar made fast to the telescope, and partaking of its motion.

Hornstein and Howlett, by inserting in the focus of the eye-piece, which for this purpose should be of the "positive" or

* Mr. Bird, however, with a mirror of only half the diameter, but reflecting more light in proportion from its silvered surface, found the brasswork greatly heated in about fifteen minutes. Much probably depends on the mode in which the apparatus is constructed.

Ramsden construction, a slip of glass micrometrically divided, project its image, together with that of the sun, as a scale upon the screen. The latter gives the following dimensions, which may be useful as a guide:—Telescope 3¾ inches aperture, in a darkened room; power 80; cardboard screen on easel, 4 feet 2 inches from eye-piece; glass micrometer in focus divided to 200ths of an inch, each division giving about ¼ inch on screen, where a corresponding scale is drawn with ink, every 16th of an inch representing about 4″. With other powers, other distances would be required for the screen. With a good telescope, magnifying may, of course, be pushed much further; but beyond 80, or at the most 90, the field would probably fail to admit the whole disc of the sun. Captain Noble states that he obtains extremely beautiful views of the solar phenomena by fitting on to the eye-piece the small end of a cardboard cone, 1 foot long, and 6 inches across the larger end, which is filled by a disc of plaster of Paris, carefully smoothed while wet on a sheet of plate-glass; on this the image is projected, the interior of the cone being blackened, and an opening cut in its side to view the face of the plaster screen.

The observer by direct vision will not be surprised if he should find a different focus required for spots in the centre and those near the limb. This is a remark of long standing, but the direction of change has not been always accordantly given. Harding (Schröter's assistant) thought the focus shorter for the marginal than the central spots; Gruithuisen, Dawes, and Hind the reverse. Gruithuisen ingeniously ascribed this peculiarity to a negative refraction in the solar atmosphere;* Dawes, more soundly, to the effect upon the eye of the different intensity of light in the two regions, which is very considerable; and this view is confirmed by similar observations that he has made upon other objects, such as the brighter and darker portions of the moon, or the planet Saturn.

COLOURS OF STARS.

The diversity of colour among the stars is a fact which is apparent upon even a very cursory survey of the heavens. To some eyes it is probably much more evident than to others; the strange phænomenon of "colour blindness,"—in other words, a defective or incorrect appreciation of difference of hue—being, it is said, more common than is usually supposed. Still, the generality of spectators would at any rate be struck with the more extreme cases; for instance, a compa-

* By a curious coincidence, Sir J. Herschel and Mr. Hunt, in the early days of photography, were led to conclude that a class of rays having peculiar negative actinic properties issue from the edges of the sun.

rison of *Wega* and *Antares*: while a more delicate and trained vision, such as that of Admiral Smyth, will distinguish very minute and proportionally numerous gradations of tint, and detect the evidence of it even among those minute objects whose presence is only brought out by a patient and stedfast gaze. The attention of observers was early drawn to this point, Ptolemy, the Egyptian astronomer, having given a catalogue of six fiery, or ruddy stars, as far back as the second century. The invention and improvement of the telescope did not lead to so speedy an enlargement of our knowledge in this, as in some other respects; partly, perhaps, because the value of such observations was not at first recognized; and partly because the man who, in other respects, was the most qualified of all to give them due prominence—Sir W. Herschel—had a preference for ruddy tints, arising either from his eye or his specula, which rendered his results less valuable as a standard of comparison. Scattered notices of colour, after his day, are frequently to be met with; but in the works of Smyth and W. Struve, the subject has been treated with especial accuracy, and Dembowski and other observers are now following it up with close attention. It was not, however, till a comparatively late period that a very interesting question arising out of it attracted adequate notice,—whether those colours might be subject to change? A curious variation of hue had indeed been described by Tycho, in the magnificent temporary star of 1572, which, having at first broken out in splendid whiteness, passed, in its decrease, through yellow and red, into a somewhat livid whiteness again; but the instance was altogether so extraordinary that it naturally might excite no suspicion as to the possibility of a similar alteration among more permanent stars. Long after, but fully a century ago, Mr. Barker, of Lyndon, pointed out the probability that such a change had actually taken place in the most eminent possible instance, that of the resplendent Sirius itself, to which the ancients ascribed a reddish tint, now, as every one knows, totally imperceptible. Several of the expressions in classical authors may be equivocal, but we can have little hesitation as to the "rubra Canicula" of Horace, and still less as to the distinct assertion of Seneca, that its redness was more vivid ("acrior rubor") than that of the planet Mars; while Ptolemy, in the list already referred to, ranks it, together with Arcturus, Aldebaran, Pollux, Antares, and Betelgeuse, as ὑπόκιῤῥος—fiery-reddish. The date of its change is unknown; but it seems probable that its redness had already become inconspicuous in the days of El-Fergani (Alfraganus), in the middle of the tenth century, and no one now would even suspect its former existence; it may, perhaps,

even be thought to verge a little toward the opposite, or blue, end of the spectrum. But, whatever probability might attach to Mr. Barker's investigation, the subject seems to have been subsequently neglected; at least, I have not noticed any further reference to it till Herschel II. and South published, in 1824, their catalogue of double stars. In this, remarking upon the smaller star of *ι Cancri,* which Herschel I., 1782, Feb. 8, had found of a deep garnet colour; Dec. 28, bluish; 1785, March 12, blue, and which they had noted as indigo blue, 1822, Feb. 22, they take occasion to inquire, "Are the colours of the stars liable to change, as well as the intensity of their light? There is no impossibility in this, and the point merits attention." This it has subsequently received, but hardly, as yet, in the degree which it deserves; the time, however, is now obviously come when a more general and rigid investigation may and should be attempted. Fortunately for amateurs, the inquiry is perfectly accessible, in the vast majority of instances, with moderate instrumental means, and, for some not very obvious reason, contrast of colour is frequently as perceptible with small as with larger apertures. And it is an inquiry which calls for an extended combination of effort, for it will be found that it is only by an accumulation of independent and concurrent testimony that we can hope to attain to any reliable conclusion. We have already touched upon this subject at the beginning of our list of double stars (INTELLECTUAL OBSERVER, No. 2, p. 148); but it is desirable to advert to it again a little more in detail. Many adventitious circumstances are unfavourable to the results of any single observer. From an inherent defect in their construction, achromatic object-glasses do not form an image as perfectly free from colour as the derivation of their name implies; there is always, under high powers, a narrow fringe of tinted light surrounding every bright object in focus; and as this tint had been originally a constituent part of the light of the star under examination, previous to its decomposition by the imperfect action of the object-glass, the focal image formed by the remainder of the light cannot be precisely of its natural hue, but must be more or less tinged with the complementary colour. By "complementary" colour is meant that which makes up the *complement* of white light after any given tint has been separated from it:—thus, considering with Sir D. Brewster that white is compounded of certain proportions of the three primary colours, red, yellow, and blue, we shall find that red is complementary to a mixture of blue and yellow, forming green; that yellow is complementary to a combination of red and blue, forming purple or violet; and that blue is complementary to an union of red and yellow, that is to say,

orange; and the same holds good with regard to the secondary or mixed colours. If, therefore, a telescope has, as usual, a fringe of blue or purple "outstanding," as it is termed, when in focus, the image of a white star will be, in proportion to the strength of the fringe, slightly stained with the complementary orange or yellow; such, for example, was the case with the noble achromatic at Dorpat—one of the first instances, if not the first, of a combination of magnitude with perfection, and with which W. Struve's great catalogue of double stars was formed; what were considered *moderate* powers in this instrument, 254 and 420, were preferable to 532 and 682, as the latter gave a yellowish tinge. And such is probably especially the case with other productions of the Munich Optical Institute, whose glasses are said to be characterized, notwithstanding their fine definition, by a great deal of outstanding blue. In addition to this never-failing source of discoloration, the fact that different object-glasses may not possess the same intensity, or precisely the same hue, of outstanding fringe, may somewhat vary the colour of their respective focal images; the material, too, of the older glasses would exercise an influence, the crown glass formerly employed having a strong green cast, from which the modern plate is comparatively free. This coloured fringe is entirely absent in reflecting telescopes, whence their focal image, when equally sharp with that of the achromatic, is more pleasant to the eye; but the Gregorian construction was apt to exhibit a "smoky" tinge; and though Newtonians, for some reason which does not plainly appear, are less subject to this, it may be readily induced by using too much copper in forming the speculum metal, or by a slight amount of tarnish. From all these defects, it is pleasant to know that the silvered specula, now coming into use,* are quite exempt, and nothing can surpass the intense purity of their reflection so long as they retain their original brilliancy, which, there is every reason to believe, may, with due care, be preserved for many years, and may be always perfectly restored with great facility. We must bear in mind, too, that even the most faithful focal picture may receive a tinge from being viewed through a defective eye-piece, though this is not much to be apprehended, provided the object is kept in the centre of the field.

* The following very interesting announcement is taken from a Paris newspaper, of May 27:—" L'Association pour l'Avancement de l'Astronomie et de la Météorologie——tiendra une Séance Générale le 3 Juin, à l'Observatoire, à trois heures de l'après-midi. Le président exposera le but de l'Association. Le nouveau grand télescope de 0m 80, monté équatorialement, sera expliqué; le procédé d'argenture du miroir sera expérimenté." The fraction of a "mètre" here given is equal to 2 feet 7½ inches, English measure.

The atmosphere also introduces a certain amount of occasional deception. It is obvious that a degree of haze which gives a red or yellow tinge to the sun by day must produce the same effect on white stars by night; and on this account the colours estimated on different nights might be found to vary, and even on the same night at different altitudes above the horizon. Hence the tints of low-culminating stars can seldom be satisfactorily determined, even if we could eliminate the effect of refraction, which interferes again in its own way, converting circular discs into lengthened and parti-coloured spectra, and sometimes, as Smyth observes, making "a large star of a white colour really appear like a blue and red handkerchief fluttering in the wind; the blue and red about as intense and decided as they could well be." The lowest 10° or 15° of the visible heavens are on this account commonly condemned by astronomers as useless; but Herschel I. found traces of this prismatic effect even as high as *Regulus*, and observed that from this cause a star was not always best seen in the centre of the field, there being a position where the prismatic error of rays passing obliquely through the eye-lens may, in some measure, correct that arising from atmospheric refraction. Struve, in later days, traced prismatic effects from this cause to 30° and even 45° from the horizon.

Some care should be taken as to the standard and nomenclature of colour, as discrepancies may arise from carelessness or inattention on this head. There is unquestionably a natural or intrinsic standard of colour in the primary tints of the spectrum, but they do not come before us in an unmingled form decidedly or frequently enough to be impressive on the memory; practically speaking, each blue that we see may be thought greener or more purple, if compared with other shades verging more to purple or green than itself; and so our ideas of yellow oscillate through a considerable interval between green and orange; and red has many variations between orange and purple. Besides this, the language of many persons is habitually vague; and in the case especially of mingled tints, different names might be given by different persons to the same colour. To obviate these causes of uncertainty Smyth's excellent suggestion should be adopted, of referring all hues to corresponding water-colour pigments, where the definite name admits of no question, provided only the memory of the eye may be depended upon.

But besides these comparatively external sources of error, we have to observe that the judgment of the eye itself may be easily led astray. To the difference which, as has been already intimated, may exist between the perceptions of different individuals, we have to add those which may casually arise in the

same eye at different times from varying conditions of the retina. To say nothing of the probability that a wearied eye would be less sensitive to slight differences of tint than a fresh one, it is well known that the long-continued impression of light of any decided colour is succeeded, upon its removal, by the appearance of the complementary hue—a fact which may be illustrated in a pleasing manner by closing one eye, and looking with the other at a white object through a piece of strongly tinted glass; this having been continued for a sufficient time till the sight is accustomed to it, let the glass be suddenly taken away, when the complementary colour will fill the whole field of vision, to an extent that will be fully manifested by opening the closed eye, which of course will see only white light. In exactly the same way, the eye which has been long gazing upon a bright yellow star, on turning the telescope to a white one, will see it tinged with the complementary purple, or, if the star was of a red hue, with the corresponding green. The cause of this phænomenon may probably be, that diminution of sensibility under a long-continued and unvaried stimulus which is common to all our perceptions. The retina becomes gradually less responsive to the action of any colour, just as it is to the action of strong white light, from prolonged exposure to its unmixed influence; and therefore when light composed of various tints is subsequently let in upon it, it fails in the adequate perception of that hue to which it has become as it were deadened, and catches chiefly the impression of the other colours in the compound, until the retina has had time to recover its normal condition. On this account, the observation of colour should never be attempted after micrometrical measurement, in which artificial illumination is employed; nor indeed at any time when the retina has just been previously stimulated by lamp or candle-light. So Struve I., who paid great attention to colours (while his assistant Knorre could distinguish none!), has cautioned us that tints observed by daylight are not to be depended upon; the impression of the blue background predisposing the eye to ascribe a tinge of complementary orange to the star, exactly as we have seen the light of a cloudy sky, penetrating through a hole in a window of greenish glass, appear distinctly of a lilac colour.

Another inquiry, and rather a troublesome one, springs out of this relation of the retina to colour. Since a coloured light of predominant intensity will obviously tinge all lesser lights in its neighbourhood with the complementary hue,* a

* It is probable that intensity of hue may occasionally overbalance mere quantity of uncoloured light. At least the slight green tint of *Sirius* when brought into the same field with *Arcturus* in Chacornac's ingenious experiment on their relative brightness, may be reasonably ascribed to that cause.

fact which may be easily illustrated by observing the blue aspect of the moon in the presence of a powerful lamp or gas-light, what certainty can be obtained as to the real colour of the smaller components of double stars, where the principal has any decided hue? In many instances, as when yellow stars are attended by little lilac *comites*, the suspicion of mere contrast naturally obtrudes itself. In others where the tints are not complementary, that of the smaller star is sure to be modified in some way, unless the principal is white; and even then it is not impossible that a small white attendant, lying within the outstanding blue fringe of the large star, might receive an orange or tawny tinge from its position—an illusion which I think I have noticed. The difficulty can only be fully met by inserting a bar or thick wire in the field, and keeping the larger star behind it by hand or clock motion, till the eye has recovered from the impression of the stronger light. By this method of artificial occultation Arago satisfied himself that most frequently the colour of the smaller star was not the mere effect of contrast; and Struve I. found that the beautiful blue of the two companions o^2 *Cygni* (No. 58 of our Double Star List, INTELLECTUAL OBSERVER, Nov. 1862, p. 304) was independent of the presence of the large orange star. Where great accuracy is desired, and a driving motion can be applied, it would be advisable, after hiding the principal star, to close or avert the eye for a short time, that an entirely fresh impression of the colour of the companion may be obtained.

When both eyes are of equal goodness, which is by no means always the case, the employment of each in succession in the examination of colour may prove an useful check upon any accidental bias in either. A change, too, of eye-pieces may always be expedient. The tints of close double stars are seldom so plainly seen with low powers as with higher ones, which give a wider separation to the discs.

Not unfrequently an observer finds considerable trouble in satisfying himself as to the tint of a star. In some cases this probably happens from the want of a standard of white light in the field. Could this be constantly introduced by the method of reflection employed by Chacornac to estimate comparative brightnesses (see last number of INTELLECTUAL OBSERVER, p. 385), it would be a great assistance, and well worth the consideration of an observer who made this subject his special study. In other instances the eye seems puzzled and the tints fluctuate. I have repeatedly remarked this in the smaller components of certain double stars—*α Piscium* being a remarkable instance—which are described as blue by Smyth, but appeared to me sometimes of that colour, sometimes tawny, in the course of a single observation. That this is not alto-

gether a peculiarity of vision I am induced to believe from the strange discrepancy that exists as to the colours of *α Piscium* (see Intellectual Observer, Feb. 1863, p. 55, No. 80). In default of a better explanation, I have thought it possible that in consequence of intense gazing the retina may have become deadened to the blue tint, and consequently would see the star white, but for the complementary orange induced by its being involved in the outstanding blue fringe of its brighter companion: this accidental hue in turn disappearing, as the eye recovers itself, to give place to the original blue; and so on. Mr. Knox agrees with me as to the existence of this fluctuation.

We must postpone to another opportunity a few more remarks upon this subject.

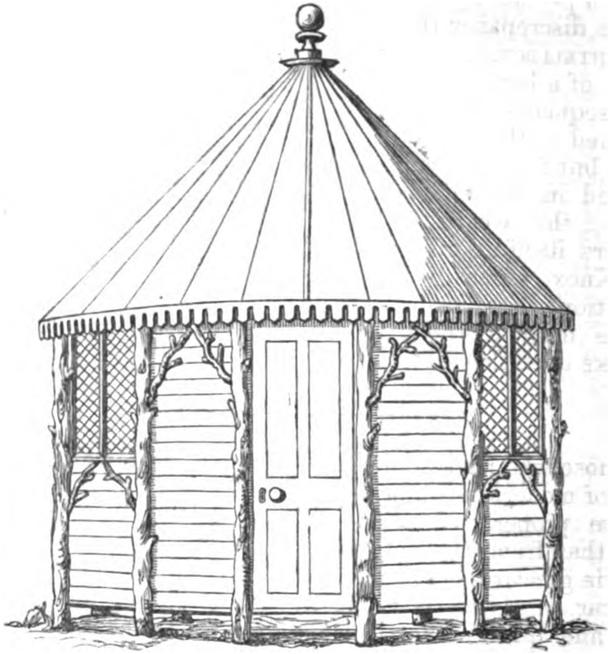
CONSTITUTION OF NEBULÆ.

Those who have studied one of the most remarkable questions of modern astronomy—that relating to the true nature of nebulæ properly so-called—will be extremely interested to learn that from the observations of Mr. Powell, at Madras, there is great reason to infer that the remarkable nebula round the star *η Argûs* is gradually but strikingly changing its form and brightness. It is figured in Herschel's *Outlines of Astronomy*, but is unfortunately not visible in European latitudes. We shall now have a renewed inducement to a closer examination of the analogous nebula in *Orion*.

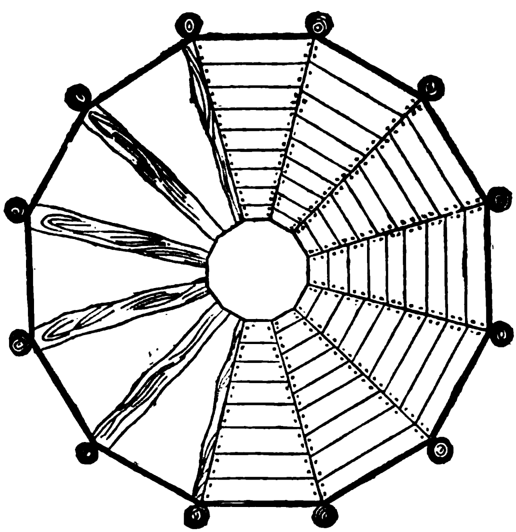
TRANSITS OF JUPITER'S SATELLITES.

July 2nd. Shadow of I. goes off 9h. 50m. 8th. Shadow of II. departs 9h. 51m. 9th. Shadow of I. enters 9h. 33m. I. leaves the disc 10h. 38m. 15th. II. goes off 10h. 2m.; its shadow entering 2m. later. 16th. I. enters 10h. 17m. 22nd. II. enters 10h. 8m. 25th. Shadow of I. passes off 10h. 5m. 29th. Shadow of III. enters 9h. 19m.

A GARDEN OBSERVATORY.



Elevation.
Diameter inside, 10 ft.; height to apex, 10 ft. 6 in.; to plate, 5 ft. 6 in.



Ground Plan. **Scale, ¼ in. to 1 ft.**

THE ROMSEY OBSERVATORY.

BY REV. E. L. BERTHON.

(*With Illustrations.*)

The following description of a very inexpensive garden observatory will most probably be acceptable to those amateur astronomers who have felt the want of a shelter for their instruments and themselves, and have hitherto been deterred from the enjoyment of such a luxury by the supposed costliness of its erection.

In the Intellectual Observer for May, 1864, appeared a description of a cheap observatory recently built by Mr. Bird for his large silvered-glass reflector, and it is, the writer is assured, with the best wishes of that able astronomer that the present account of a *cheaper* observatory makes its appearance.

It is not necessary to repeat the cogent reasons that those who study the hosts of heaven in the chilly night should do so with as much comfort as possible. A cutting wind on a frosty night, which agitates both the observer and his telescope together, is the best argument in favour of laying out a few pounds for such a purpose.

The drawings which accompany this description represent, in elevation and ground plan, a very pretty rustic observing-house, which the writer erected in the garden of Romsey vicarage last summer; it has answered every desired purpose most perfectly, and though the situation is wet, being almost surrounded by water, the building itself is remarkably free from damp of every kind, not a speck of rust having appeared on some bright steel and iron work kept in it the whole winter. It will be seen that the form of the building is twelve-sided, and the following particulars will enable any one desirous of adopting the design to build it:—

Twelve rough fir poles, or any straight trees, about four inches thick and eight feet long, are fixed in the ground in a true circle ten feet diameter, and at equal distances from each other, *i. e.*, about two feet six inches; their tops must then be cut off level six feet six inches above the ground.

To do this part of the work quickly and well, a straight post should be set up in the centre of the circle, on the top of which a horizontal rod five feet two inches long is made to revolve; this will indicate the height of each post and the position of the centre of its head. This being done, some pieces of inch deal or other plank must be cut just long enough to

reach from centre to centre of the posts, and these twelve pieces, four inches wide, must be nailed on their tops.

The walls of the house must now be made by nailing weather-boards on the inner sides of all the posts, beginning at the upper part, and only leaving the apertures for the door and windows.

The bearers for the floor can be laid next; they consist of slabs of any kind of timber with their smooth sides up. Supposing the brick or stone pedestal for the telescope to be two feet in diameter, these slabs will be four feet long; they may be supported on logs of wood, or any other blocks, so that the floor when laid upon them is one foot above the ground. Care must be taken that neither they nor the boards touch the pedestal.

The ground plan shows the arrangement of the boards, five of the spaces being left open in the drawing to show the bearers.

The door and windows can be made according to the taste of the builder, but simple and neat cases for them can be formed by nailing inch board, planed, against the rough posts. Very simple frames for the windows, with one large square of glass in each, look quite as well as casement, and are very cheap.

The next part is the roof, which is constructed as follows: —Twenty-four pieces of inch plank, about six inches wide and between two and three feet long, are so cut that twelve of them shall form a circle ten feet three inches wide at its inner edge; these being laid out in a true circle, marked in chalk upon a flat floor, the other twelve are laid upon them, crossing the joints; they are then all nailed together and clinched. The inner edge is then made to a true circle, and smoothed with a compass plane.

Next the rafters must be cut, twelve or twenty-four in number, or intermediate as best suits the canvas. The Romsey Observatory has twenty-four; they are seven feet six inches long, and two by one inch thick. Being cut to the right bevel, their feet are simply nailed down to the great wooden ring above described; their upper ends meet on a block surmounted by a knob.

Strong canvas is now to be nailed with tinned tacks upon the rafters. A space will be left in the roof nearly six feet wide, wherein no rafters are fixed. It is the opening for the telescope, and is closed with shutters in this way:—Suppose the number of rafters be only twelve, then *two* triangular frames of the same wood, each comprising one-twelfth part of the cone, will be hinged to the contiguous rafters on each side, and the canvas nailed over the joints. A broad thin strip of

wood covering the part where these shutters meet will keep out the rain; the only place where it might come in is at the extreme apex, and to prevent it a round disk of zinc must be put on under the knob, but high enough above the upper ends of the rafters to allow the triangular shutters to open. The writer has constructed his shutters in four pieces, hinged two and two together, so that he can open them from eighteen inches to six feet.

The roof being completed and well painted inside and out, is ready for lifting on, which can be done *bodily;* but first the gear for causing it to revolve must be contrived. For this purpose eighteen iron sash-rollers of good size must be got from any good ironmonger. Twelve of these must be sunk in the plates of wood on the top of the posts, and just over them. The other six rollers must be attached to some stout blocks of wood, so as to revolve vertically, and these blocks will be screwed to the plate, between the posts, in alternate spaces, so that when the roof is on, the inner edge of the great ring or circle touches, or may touch them, to prevent the roof going off sideways. The twelve rollers should be well oiled, and they will be found to bear the roof, and allow it to revolve with a very moderate force.

The shutters must have a bolt to keep them shut; and about four bent pieces of iron driven into the top of the posts, with a sort of hook projecting a little over the inner edge of the great circle of the roof, will keep it from being lifted by the wind.

It only remains to remark that the extreme dryness of this building arises from its being raised a foot clear from the ground, but it is better and warmer if roofing-felt be nailed on inside the boards. Some very cheap stuff, cotton or linen, etc., nailed inside the felt will receive the paper which, with a simple cornice, finishes the interior.

The weather-boards outside can be tarred over or painted roughly, and where loppings of oak can be had, some of the crooked branches put on in a gothic pattern produce a very pleasing effect. The eaves can be ornamented according to taste or local facilities.

The following is an estimate for materials and labour on a high computation, not including the pedestal of the telescope; but in most parts of the country, especially where English fir can be obtained, and the wages of a carpenter are less than five shillings a day, a considerable saving may be effected, so that the expense of this pretty little building will vary from seven to ten pounds, according to local circumstances:—

	£	s.	d.
Twelve rough fir poles	£0	12	0
One hundred and sixty-five feet of three-quarter inch weather-board for sides, at 2*d*. per foot	1	7	9
One hundred and sixty feet of inch deal board at 2½*d*. per foot, for floor, plate, windows, door, and entire roof . .	1	13	4
Slabs for bearers of floor	0	4	0
Fifteen yards of yard-wide canvas at 1*s*. 4*d*.	1	0	0
Eighteen sash-rollers (iron)	0	3	0
Nails, screws, and tacks	0	8	0
Lock, hinges, and bolts	0	6	0
Eight square feet of glass for windows at 3*d*.	0	2	0
Eighteen yards of roofing-felt for inside of weather-boards	0	12	0
Eighteen yards of lining	0	6	0
Paint, etc.	0	6	0
Labour, twelve days at 5*s*.	3	0	0
Total	£10	0	1

ON THE ORIGIN OF THE LIGHT OF THE SUN AND STARS.

BY BALFOUR STEWART, M.A., F.R.S.

When we turn our eye upwards and behold the sun, or gaze by night on the starry firmament, and reflect that those glorious orbs have shone through unnumbered ages, we cannot fail to be impressed with the majesty of that Great Being who upholds them in all their brightness. But if we descend from the great First Cause to those modes of action in accordance with which we are assured the universe is governed, and search for the source and fountain of this brilliancy, we have to grapple with one of the most perplexing problems in the history of Science.

And this perplexity has only increased with the progress of knowledge, nor has it ever been greater than it is at present. In the days of old the sun was looked upon as a ball of fire, and no question was raised about the source of his heat. But in proportion as we have become better acquainted with the various probable sources of light and heat, and are convinced that the laws of matter, nay, even its very forms, are the same throughout

the universe, in the same proportion are we perplexed to assign the producing cause of such a wonderful outflow of luminosity.

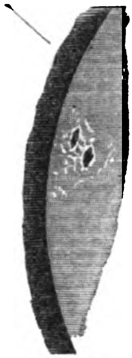
All speculations on this subject naturally divide themselves into two groups. We have, in the first place, those which assume that the sun and stars are fed from within; and, in the second, those which assert that they are fed from without. A little explanation will make this distinction clear. If we suppose the sun to be a huge mass at a very high temperature which is gradually cooling, and therefore giving out light and heat, or if we suppose his brightness to be due to chemical combination of the substances which form his mass, in either case we assert that he is fed from within. But, on the other hand, if we suppose that he is fed by comets, or by meteors impinging against his atmosphere, and having their motion converted into heat (just as they have when they impinge against the atmosphere of the earth), or by an external ether, or in any way by planets, then we assert that he is fed from without. In presuming to add another to the list of these speculations, let us begin by laying down certain rules to guide us in our discussion.

Now, first of all, our hypothesis must not be inconsistent, or only barely consistent with appearances on the sun's disc; and, in the second place, it must be susceptible of application to other systems, and capable, by a legitimate extension, of explaining the very strange and even startling phenomena which reach us from those distant regions. The sun, in fine, must not be regarded as an individual apart by himself, but rather as that member of a large family with whom we are best acquainted, and who, if questioned aright, may perhaps inform us of the habits of his race. What, then, are the phenomena which he presents? It is well known that his surface, although generally appearing uniformly luminous to the naked eye, is not so in reality. Setting aside spots for the moment, the centre of his disc is decidedly brighter than the circumference; leading us to infer that the sun, like our own earth, is surrounded by an atmosphere which absorbs much of the light which passes through it in an oblique direction. It is likewise worthy of remark, that this atmosphere must have a lower temperature than the region which gives rise to the luminosity, since otherwise it would not exercise an absorptive influence upon the light emitted, but would add as much as it took away, or even more, if its temperature were higher. The dark lines in the solar spectrum are likewise a proof of the presence of an absorbing atmosphere of low temperature.

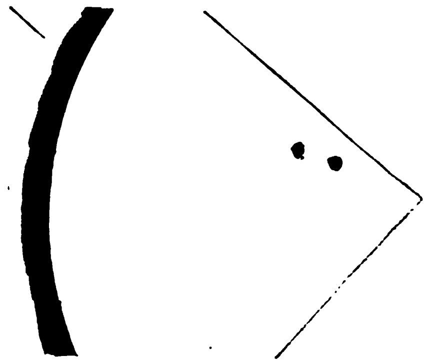
But the spots which appear from time to time on the sun's surface are at once the most interesting and instructive of all solar phenomena. Their existence has been known for a long

time, but it is only lately that they have become the subject of scientific study. The following sketch from solar photographs taken at the Kew Observatory will give an idea of these curious objects :—

Left Limb of the Sun,
1863, July 5th, 12h. 24m. p.m.



Left Limb of the Sun,
1863, July 6th, 11h. 40m. a.m.



Left Limb of the Sun,
1863, July 10th, 12h. 17m. p.m.

In the first of these pictures we perceive a group consisting of two spots, which has just been brought into the field of view by the rotation of our luminary. It will be noticed that, beyond the spot at the extreme edge, there is a slight luminous thread, otherwise this spot would have produced an apparent indentation in the sun's limb. In the next picture the group has advanced a little further into the disc; and we now see a large quantity of bright flocculent matter floating about chiefly between the two spots. We likewise perceive from this, as well as from the previous picture, that the circumference of the disc is less luminous than its more central portions. The second picture affords us also an opportunity of observing minutely the two spots which form the group. We see that each consists of a black nucleus, accompanied by a penumbra, which, in the left-hand spot, is almost, if not quite, to the left of the nucleus. In the third picture, that group has advanced nearly to the centre of the disc; and here we find, in both spots, that the nucleus is very nearly central with respect to the penumbra, and that there is a total absence of bright flocculent matter, or faculæ, as this is sometimes termed.

By the nearly unanimous opinion of observers, spots have been regarded as breaks in the photosphere of the sun, through which his comparatively dark body becomes visible. The first scientific observer was Dr. Alexander Wilson, of Glasgow, who upheld this hypothesis by endeavouring to show that when a spot is near the sun's limb, the nucleus is generally nearer the

centre than the penumbra. From this he argued that a spot represents a cavity of considerable depth in the sun's atmosphere; the dark body of our luminary forming the nucleus or bottom, while the penumbra represents the atmospheric walls or sides of the cavern; a consequence of which will be, that when a spot is placed obliquely towards us, the wall nearest us will be hidden from our view, and we shall only see that which is farthest away. It will be noticed that one of the spots we have sketched confirms the truth of this explanation, the penumbra being to the left of the nucleus when the spot was near the sun's left limb.

Let us now consider the light-clouds, or faculæ. Messrs. Dawes, Howlett, and others, have observed that a spot, when near the edge of the sun, does not cause an apparent indentation in the limb, as might be expected, but that there is always a thin line of light beyond. This is also seen in our sketch, and the original negative at Kew from which it is taken, is exceedingly instructive and well worthy of minute inspection. It represents the line of light at its central portion as more luminous than the general body of the sun, so that the eye is impressed with the idea of an excessively curved or bulging out line. This may be due to the elevation of the luminous ridge above the body of the solar atmosphere, and is in accordance with the well known fact that when faculæ are observed near the limb of the sun they appear much brighter than the surrounding photosphere, as if by being high up they escaped a great portion of the atmospheric medium which absorbs very much of the light proceeding from the border.

On the other hand, faculæ have little or no excess of brightness when near the centre of the disc, because there the light travels only through a small extent of atmosphere and there is not much gained by escaping it. To all this we may add, that Mr. Warren De la Rue has succeeded in producing a stereoscopic image of a spot in which the faculæ appear raised above the surface. Now if these faculæ are really elevated, this seems at once to inform us that the sun's light breaks out in his atmosphere and does not come from his solid body, since we cannot easily suppose large masses of heavy matter remaining upheld at a great height for a long period of time. We therefore conclude that the greater proportion of the light which reaches us is not derived from the solid body of the sun, but from some matter which either floats in the solar atmosphere or forms part of this atmosphere itself, and also that as far as our observation of spots extends, there is ground for supposing the sun's surface to be deficient in luminosity; and, for a body of indefinite thickness, this is equivalent to a reduc-

tion of temperature. It is of course possible to imagine that a peculiar cooling process takes place, so that the body of the sun, originally very bright, is greatly reduced in temperature when we behold it, but such an hypothesis bears the appearance of patchwork, and even if it account for solar phenomena, it will not admit of extension to other systems. From all this, we are induced to suppose that the sun's light is due to action from without; and if it can be proved, as we think it can, that a disc full of spots is deficient in luminosity, it would seem to follow that such a state of the sun's surface implies a deficiency in the intensity of this mysterious action; while, on the other hand, a disc free from spots denotes an increase of the same.

If we now direct our adventurous flight into still more distant regions, we shall find evidence of very extraordinary forces at work in stellar spaces. We allude to variable, temporary, and binary stars. Of the first and second of these classes we shall here name one or two of the most prominent examples.

1. Omicron Ceti has its greatest brightness for a fortnight, decreases for three months, is invisible five months, increases again for three months, arriving once more at its greatest brightness.

2. Algol in Perseus appears for about sixty-two hours as a star of the second magnitude; it then suddenly becomes fainter, and in three hours and a half arrives at its minimum; it then begins to revive, and in three hours and a half more is again at its maximum brightness.

3. Gamma Cygni is visible for about six months, and invisible for about the same time or a little longer.

The appearance of a temporary star about 125 years B.C., which shone forth for some time with extraordinary brilliancy and then died away, turned the attention of Hipparchus to astronomy, and induced him to form a catalogue of stars. In the year 389 A.D., a star shone forth with extreme brilliancy near Alpha Aquilæ, remained for three weeks as bright as Venus, and then disappeared. A star of this kind was first seen by Tycho Brahé in November, 1572. It was at its greatest brilliancy when discovered, diminished gradually in brightness for sixteen months, and disappeared in March, 1574. There was no change in its apparent place. Kepler also saw a new star on the 8th of October, 1604. It had suddenly become visible, was of great lustre, and disappeared after twelve months.

This is perhaps the fittest place to notice the behaviour of binary stars. A binary star denotes a system generally of two members which revolve about one another in ellipses frequently of great eccentricity. A change of magnitude in the components of some of these systems has been observed, and, as far as can be gleaned from an interesting paper by Professor

Piazzi Smyth, when this is the case both components change together and in the same direction. We may soon hope to learn something more definite regarding these bodies, which are favourite subjects of study, but in the meantime our knowledge is very limited.

From all this it is evident that in the case of many stars we cannot suppose the light to be due to an incandescent solid or liquid body, otherwise how can we account for their long-continued disappearance? Goodricke indeed has supposed that dark bodies may periodically obscure them, but the objection to this hypothesis is, that such a dark body would be of a size utterly disproportioned to that of any ordinary star. Nothing appears so capable of explaining all these phenomena as the supposition that the luminosity of stars is derived from without, and that when the source of excitement fails or varies we have a temporary or variable star. Driven, therefore, to look without for the source of solar and stellar light, let us examine the various hypotheses which have been proposed.

It has been argued that the etherial medium which pervades space may somehow produce luminosity at the surface of large bodies, towards which it may be supposed to stream, and that some of its streams being stopped by planets or other bodies, this may occasion a variation in the light of the primary; yet how, on this principle, are we to account for the total stoppage of light for a lengthened period of time? Again, it has been supposed that our sun is fed by meteors, which, falling into his atmosphere, have their motion at once converted into light and heat. Accordingly, when a star is in a portion of space rich in meteors, its brightness will be intense; but when in a space devoid of meteors, it will disappear. This will readily account for the behaviour of temporary stars, but it cannot easily be tortured into affording us an explanation of variable ones. In advancing our own views, let us remark that in a case like the present we should endeavour to connect together such phenomena as are periodical. Can these appearances, then, be in any way due to planets? And again, since observation only can decide this question, have the spots on our own sun any relation to planetary configurations? In the valuable work on sun spots, recently published by Mr. Carrington, a comparison is instituted between the frequency of sun spots and the radius vector of Jupiter, and on the whole there are good grounds for supposing that the least distance of Jupiter from the sun corresponds in epoch to the minimum of spot-frequency, and his greatest distance to its maximum. It may be added that in 1837 the number of spots was peculiarly great, and that both Jupiter and Saturn were then nearly at their greatest distances

from the sun. Furthermore, an examination of the sun-pictures taken by the Kew heliograph, seems to indicate the following law. Any portion of the sun's disc which, owing to his rotation, recedes from the neighbourhood of Venus, acquires a tendency to break out into spots, and as it approaches Venus it acquires a tendency to be free from spots. On the whole, therefore, we are perhaps entitled to conclude that, in our own system, the approach of a planet to the sun is favourable to luminosity, and especially in that portion of the sun which is next the planet. A confirmation of this law is found in the readiness with which it may be adapted to other systems. Let us take variable stars. The hypothesis which without being physically probable gives yet the best formal explanation of the phenomena there presented, is that which assumes rotation on an axis, while it is supposed that the body of a star is from some cause not equally luminous in every part of its surface. Now if, instead of this, we suppose such a star to have a large planet revolving round it at a small distance, then, according to our hypothesis, that portion of the star which is near the planet will be more luminous than that which is more remote, and this state of things will revolve round as the planet itself revolves, presenting to a distant spectator an appearance of variation with a period equal to that of the planet. Let us now suppose the planet to have a very elliptical orbit, then for a long period of time it will be at a distance from its primary, while for a comparatively short period it will be very near. We should, therefore, expect a long period of darkness, and a comparatively short one of intense light—precisely what we have in temporary stars. Again, we have seen that in many binary systems there is a change of magnitude, and that perhaps both members change at the same time and in the same direction—a result in favour of our hypothesis; but it is to be regretted that we have not yet sufficient data for determining if the brightness is greatest when both members are nearest together. Perhaps it may now be asked, If the sun have not a large store of heat in himself, but is fed from moment to moment, have we any guarantee for the continuance of his light, or for its steadiness, which is almost of equal importance to our well-being? We reply, that our sun is not the member of a binary system of small period and large ellipticity, which might give him a variable brightness, nor is he surrounded by planets that now press near to him and anon recede to a great distance, which might produce the same result. No doubt we encounter occasionally an erratic comet and are much puzzled by its great luminosity and, in other respects, strange behaviour, as it approaches our sun, but the influence of a body of such small mass upon our luminary is probably inappreciable.

We have thus endeavoured to show that the formal law which appears best to represent celestial phenomena, asserts that the approach of two heavenly bodies produces light. Now what physical cause does this imply? It has been remarked by the writer, in conjunction with Professor Tait, that we are not without an analogous law in another branch of science, for we know that the approach of two atoms towards one another also produces light. Again, is it not conceivable that the law indicated in this paper may be merely that arrangement by means of which the visible motion of bodies is converted into light and heat, which we know, from Professor Thomson, are the ultimate forms to which all motion tends. This problem is one of great interest, but it can only be solved by laborious observation.

LITERARY NOTICES.

OUTLINES OF ASTRONOMY. BY SIR JOHN F. W. HERSCHEL, BART., K.H., etc., etc. Seventh Edition (Longmans).—There are very few scientific works that can compare with Sir John Herschel's well known "Outlines of Astronomy," as a masterly exhibition, not only of the fundamental facts, but of the methods of reasoning in the higher branches of physical inquiry. Many writers have succeeded in giving intelligible explanations of the principal astronomical laws, and of the results to which they give rise; but we could name no book equal to the "Outlines," in its capacity of making physical science an aid to a vigorous and yet pleasurable training of the mind. The leading facts and principles of Astronomy remaining unchanged, that which was well said concerning them when the first edition of Sir John Herschel's work left the press, is equally applicable now that the seventh edition appears in answer to public demand; but still there are some departments, in which recent researches have unfolded new truths, that require more notice than they have received in the volume before us, which is very little more than a reprint of the last edition. If Sir John Herschel's age and engagements prevented his paying due attention to the views concerning the constitution of the sun, which have been unfolded by the application of the spectroscope, and by considerations resulting from the mechanical theory of heat, and to other recent speculations and observations, it would have been wise to have transferred the task of bringing out a new edition of his famous work to his son Alexander, who has displayed scientific capacities of no common order, and bids fair to be known to posterity as the third of his illustrious name. But although we thus express a wish that we had been favoured with a little more, that which Sir John again offers to us is essential, and nowhere else presented equally well.

Instances of the Power of God as manifested in his Animal Creation: A Lecture delivered before the Young Men's Christian Association, Nov. 17, 1863. By Professor Richard Owen, D.C.L., F.R.S. (Longmans.)—This is the lecture that gave rise to so much discussion and anger in the minds of certain well-meaning gentlemen whose defective training peculiarly needed to be supplemented by the kind of instruction which Professor Owen provided for them. No one can doubt the religious tendency of Professor Owen's mind: he has always contemplated science in the light of natural theology, and his main line of argument would be followed by nine-tenths of that now numerous section of the clergy who have thought their performance of duty incomplete without a reverent study of God's works.

The Rose Book: A Practical Treatise on the Culture of the Rose; comprising the Formation of the Rosarium, the Characters of Species and Varieties, Modes of Propagating, Planting, Pruning, Training, and Preparing for Exhibition, and the Management of Roses in all Seasons. By Shirley Hibberd, F.R.H.S., etc., etc. (Groombridge and Sons.)—Every family tries to grow roses after a fashion, from those who confine their labours to a humble pot in the chamber or window sill, to those who can afford to lay out rosariums, or line long garden-walks with the all-favourite flower. Rose culture is indeed one of the most important branches of gardening as a fine art, and thousands are annually baffled and defeated for want of the practical instruction which Mr. Hibberd here gives. The wealthy cultivator with acres of lawns and beds, will derive from his pages ample information, much of which is usually concealed as a secret of the craft, while more modest growers will be saved from many a mistake. To the inhabitants of towns and suburban districts, he affords great comfort by indicating what sort of roses they must choose, and how they must treat them to ensure success. Mr. Hibberd is well known as a most indefatigable experimenter, and what he recommends to others he has first tried and proved for himself.

The Temple Anecdotes. By Ralph and Chandos Temple. Invention and Discovery. Illustrated; published monthly. No. 1. (Groombridge and Sons.)—Everybody likes good anecdotes, and everybody likes good illustrations; and here they are, at a price wonderfully low, considering the admirable quality of the type, paper, and engravings. No. 1 of the "Temple Anecdotes" contains twenty-eight anecdotes of great inventors and great inventions, besides a brief introductory essay on the "True Mother of Invention." Arkwright, Cuvier, Stephenson, Crompton, Brunel, Buckland, Watt, and Wollaston, are among the heroes of the incidents narrated, and the editors have shown industry and discretion in hunting up striking and little known facts. Arkwright's wife destroying his models, and an incident in the childhood of James Watt, furnish subjects for two full-page elaborately-executed engravings, which belong to a style of art seldom seen in cheap publications. They are both good, but the second is especially

admirable both in design and execution. The earnest boy tracing his mathematical diagrams on the stone hearth, unconscious that his father and two visitors are watching him; the calm, thoughtful satisfaction of the parent, who is hopefully speculating on his child's future career, and the varied expression of the two ladies, are presented to us by the artist with a force and fidelity seldom seen in more pretentious works.

THE ABBEVILLE JAW: An Episode in a Great Controversy. By J. L. ROWE, F.G.S. (Longmans.)—This is a paper read before the Hull Literary and Philosophical Society. The author is a bit of a humourist, and his chief object seems to be to promote a sort of compromise between those who assign a brief date to man's existence, and those who claim for him a long antiquity.

RAMBLES IN SEARCH OF FLOWERLESS PLANTS. By MARGARET PLUES. (Cottage Gardener Office, Houlston and Wright.)—This handsome and elegantly illustrated volume is a good specimen of a class of works to which the popularization of science is mainly due. It affords just the sort of help that beginners want, and will be very useful in country trips. The subjects range from ferns to mosses, algæ, lichens, and fungi. Miss Plues writes in an interesting, agreeable style; and her directions for the finding of objects and the identification of species are judiciously conveyed. Those who want instructions for collecting a class of objects of great microscopic interest, will find an additional reason for thanking an accomplished lady for her instructive work.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ROYAL INSTITUTION.—*May* 13.

ON THE MECHANICAL EFFECTS OF GUN COTTON.—In the May number of the INTELLECTUAL OBSERVER, page 302, will be found an account of Professor Abel's lecture at the Royal Institution, "On the Chemical Properties and Preparation of Gun Cotton." Mr. Scott Russell has supplemented this lecture by a second "On its Mechanical Action and General Practical Utility." Gun cotton, as prepared by the Austrian process, is uniform in quality and permanent in action; it possesses the greatest cleanliness in use, not fouling the gun as gunpowder does, and hence possesses great advantages for use with breech-loading arms.

Exploded in the open air it acts differently from gunpowder; if the latter is exploded in one pan of a pair of scales, the arm of the balance is violently depressed. An equal weight of gun cotton,

on the contrary, can be ignited without moving the pan. In the same manner a bag of gunpowder will blow open the gate of a town which would not be injured by an equal weight of loose or unpacked gun cotton. This appears to arise from the circumstance that gunpowder after explosion leaves about 60 per cent. of solid matter, which acts as a charge and produces the effect of a shot. On the other hand, the products of the explosion of gun cotton are nearly purely gaseous. According to Karolyi these products are—

Carbonic Acid	20·82
Carbonic Oxide	28·95
Nitrogen	12·67
Hydrogen	3·16
Marsh Gas	7·24
Water	25·34
Carbon	1·82

The character of these products appears to account for the circumstance that with gun cotton there is only two-thirds the amount of recoil that is produced by gunpowder in a clean gun; for as sixteen pounds of powder produce by the explosion ten pounds of solid matter, which has to be sent out of the gun at a high velocity, the recoil must be necessarily greater than with gun cotton of equal explosive power, the products of whose combustion is entirely gaseous.

Gun cotton, when employed in artillery service, is found not to heat the gun in the same manner as gunpowder does; this is probably due to the fact that a large quantity of steam is formed during its explosion. This renders so large an amount of heat latent that the gun is not sensibly warmed.

Unlike gunpowder, gun cotton can be wetted and dried repeatedly without injury. This introduces a great element of safety in the manufacture, which is carried on for the most part whilst the gun cotton is damp and consequently inexplosive.

Enclosed in a case or gun the effect of gun cotton is three times greater than that of powder, one pound doing the work of three of powder. Twenty-five pounds of gun cotton placed in a box at the foot of a palisade formed of trees twenty inches in diameter, was found to shatter three of the trees to minute splinters, and to open a wide passage available for military purposes. Four hundred and fifty pounds of gun cotton exploded in the water, twenty feet distant from a vessel of 400 tons, utterly destroyed the ship, some of the fragments being blown upwards of 400 feet high in the air.

Employed for mining purposes it is found that one-twelfth the weight of the coarse mining powder previously used is equally efficient.

In confined places, such as mines and casemates, the absence of sulphurous smoke enables the workmen or soldiers to continue firing any length of time without inconvenience, often a point of great practical importance.

The relative power and properties of gunpowder and gun cotton may be inferred from the following table—

GUNPOWDER.	GUN COTTON.
100 lbs. occupy 1·8 cubic feet	100 lbs. occupy 4 cubic feet.
55·5 lbs. occupy 1 cubic foot.	25 lbs. occupy 1 cubic foot.

PRODUCTS OF EXPLOSION.

10 0 lbs. yield on explosion,	100 lbs. yields on explosion,
68 lbs. of solids,	25 lbs. of steam,
32 lbs. of gases,	75 lbs. of permanent gases.

At a lecture delivered at the United Service Institution, Professor Abel combated some of the conclusions arrived at by Mr. Scott Russell, particularly that which attributes the great recoil produced by gunpowder to the projection of the solid residue remaining after the explosion. Professor Abel contended that some of the materials regarded as solid by Mr. Russell, excited a state of vapour at a red heat, particularly the sulphide of potassium, which forms a considerable proportion of the residue. It was also shown that the amount of recoil depends greatly on the mechanical aggregation of the explosive body. Loose gun-cotton exploded on one pan of a pair of scales producing no depression, whereas, if plaited into a cartridge, its effect is well marked.

In the same manner, the recoil produced on a balance by the explosion of gunpowder is much lessened by previously reducing it to a state of fine powder. From these and other considerations, Mr. Abel regarded the theory advanced by Mr. Russell to account for the greater recoil of gunpowder as unsatisfactory.

May 19.

TEMPERATURE AND CLIMATE OF THE MOON.—Mr. Nasmyth, who has devoted many years to the diligent observation of Lunar Phenomena, communicated the results of his observations to the members of the Royal Institution, at the Friday evening meeting of this date.

The bulk or solid contents of the moon, as compared with that of the earth, is as 1 to 49. The surface of the moon, as compared with that of the earth, is as 1 to 16. On the supposition that the moon and the earth were formed at the same period, by the condensation of nebulous matter, the rapidity of cooling of the moon would be four times as great as that of the earth, in consequence of its greater surface as compared with its solid contents, hence the moon would have become solid long before the earth, and would offer for our contemplation an object of immense antiquity, the surface of which, from the absence of air and water, would, according to Mr. Nasmyth's hypothesis, have undergone no disintegration or change for millions of ages.

The present condition of the moon's surface, consisting of numerous craters of extinct volcanoes, some, twenty-eight miles in diameter, is in course of description by Mr. Webb in the INTELLECTUAL OBSERVER. Some of these volcanic mountains are 28,000 feet high. These are brightly illuminated on one side by the sun; and from the absence of diffused daylight, owing to the want of an atmosphere,

the further side is in shadow of intense blackness; and from the same cause the sky, as seen from the moon, would appear perfectly dark, the stars being always visible.

The day in the moon is a fortnight in duration, and during this period the temperature on the illuminated side would probably rise to 220° Fahrenheit, or hotter than boiling water. The night would be of equal length, and during this time the heat, from the absence of aqueous vapour and atmosphere, would be radiated freely into space, and the temperature would fall to that of space, viz., to 300° below zero Fahr. The absence of air and water in the moon would render impossible the existence of animal and vegetable life corresponding to that which prevails on our globe.

The use of the moon, as a satellite of the earth, is usually regarded as being that of a luminary, but from its variable action this use must be regarded as secondary. Its value as inducing the tides and currents of the ocean is of greater importance, both as conducing to the sanitary condition of the sea, and as aiding transit in rivers, by the ebb and flow of the tide. At the conclusion of the lecture, Mr. Nasmyth illustrated the formation of the radiating cracks on the moon's surface, by congealing water in a thin glass globe hermetically sealed—when it cracked in lines radiating from a single point—the cracks in the moon being attributed to the contraction of its external hardened crust during the period of its rapid congelation.

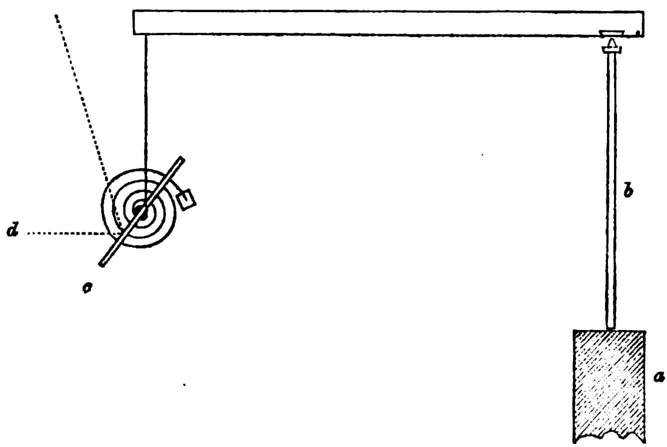
June 10.

New Magnetic Experiments.—Professor Tyndall concluded the series of Friday evening discourses, at the Royal Institution, by a Lecture "On a New Magnetic Experiment." After demonstrating the familiar properties of magnetized bodies, he entered into a consideration of the changes of arrangement which the molecules of a piece of soft iron must undergo when it is converted into a temporary induced magnet, by the passage of a current of electricity through the coils of copper wire surrounding it. These molecular changes are proved by the fact that, when a bar of soft iron is magnetized and demagnetized, in succession, by rapidly breaking and remaking the current in the surrounding coil of wire, it is thrown into a state of vibration which produces a sound in the air. This alteration of the molecular arrangement was supposed by Ampère to be attended with a shortening of the bar of soft iron. Mr. Joule, however, has proved that the bar is actually lengthened when it is converted into an induced magnet. The experiment demonstrating this fact was shown in public for the first time.

A bar of soft iron, two feet in length, was firmly secured in an erect position. On its upper extremity was a vertical rod of brass, the lower end of which rested on the top of the iron bar; the upper, tipped with a steel point, pressed against a small plate of agate, near the fulcrum of a horizontal lever. At the distant end of the lever was a very fine wire, which was kept coiled around an axis by the tension of a fine hair spring. This axis turned a small mirror. The action of this exceedingly delicate instrument is easily ex-

plained. When a current of electricity is sent in a coil around the iron bar, *a*, only the upper end of which is shown in the diagram, it is lengthened to a very minute degree, consequently it presses upwards the brass rod, *b*, and this acting on the lever raises the free end, uncoiling the wire round the axis, and bringing the mirror, *c*, to a position more nearly approaching the perpendicular. This action is so slight that to render it visible to the audience, a horizontal ray of light, shown in the diagram by a dotted line, was reflected from the mirror on to a screen at some distance, when the slightest movement of the mirror was rendered evident by the alteration in the position of the ray, *d*. On magnetizing the iron, the reflected ray was depressed, and on breaking the current the ray returned to its original position.

So exceedingly delicate was the entire apparatus, that the ejection of a few drops of warm water from a pipette upon the iron bar,



produced an immediate depression of the reflected ray. The probable explanation of the lengthening of the iron bar under the influence of the electric coil is, that the particles have a tendency to arrange themselves along the lines of magnetic force, in the direction of the bar. This explanation is supported by a beautiful experiment of Mr. Grove's, which was also shown for the first time at Professor Tyndall's lecture. A cylinder, with glass ends, was filled with a mixture of magnetic oxide of iron and water. This formed a muddy liquid, through which a ray of light could hardly pass. On placing this in the centre of an electric coil, it was found that on making the current the particles, being free to move, arranged themselves in the direction of the axis of the cylinder, and the ray of light passed through with less obstruction. On breaking the current in the coil, the liquid again became muddy and opaque.

ENTOMOLOGICAL SOCIETY.—*June* 6.

Artificial Modification of Wasps' Nests, and Intelligence in the Honey-Bee.—Mr. Smith, of the British Museum, exhibited a very curious series of boxes. These were from eight to ten inches in height and width, and had either on one or two sides glass, as in cases intended for stuffed animals. Inside of these there were wasps' nests, which were most singular in their arrangement. Some looked like the pillars of a cathedral, others reminded the spectator of limestone caverns, and a third called up decided reminiscences of Stonehenge. These remarkable structures had been formed in each case by one set of wasps. They had been sent for the inspection of the society by Mr. Stone. He found that he could ensure the construction of wasps' nests wherever he chose to make chambers in the earth suitable for the queen wasp to build in. When a nest has been made, he takes it from the earth, puts it in one of the boxes prepared for its reception, and allows the wasps to work in it as long as he wishes, which is generally only a few days. The precise manner in which he determines the plan of their building was not mentioned. It appeared, however, that wires formed the foundation of the architecture, and that the wasps surrounded these with the masticated wood of which they construct their nests. The forms obtained were ingenious and interesting.

Mr. Tegetmeier described an example of intelligence in the honey-bee which has hitherto escaped observation. It is well known that a swarm of bees often take possession of an old tenantless hive filled with comb, having previously visited the hive and cleaned away the refuse materials and damaged portions. On placing a frame-hive, in which old combs had been artificially attached, near a stock that was expected to throw off a swarm, it was seen that the bees visited it, and that numerous scales of newly-secreted wax were found on the floor-board. This led to an attentive examination of the combs, and it was discovered that new white wax had been secreted in the empty hive, and that this had been employed in repairing the combs, particularly in cementing them more securely to the top of the hive, their attachment being strengthened at that point where the greatest weight would have to be sustained when the combs should be filled with young brood, honey, and pollen. It appears an extraordinary instance of foresight and intelligence, as distinct from unreasoning instinct, that the bees, when proposing to send out a swarm to tenant a new residence, should not only clean the hive, but send a relay of worker-bees to cluster and secrete wax in order to strengthen the combs at that part where the greatest weight will have to be supported.

GEOLOGICAL SOCIETY.—*June* 8.

On the Geological Structure of the Malvern Hills and Adjacent District. By Dr. Harvey B. Holl.—The object of this com-

munication was to discuss the structure and origin of the crystalline rocks of the Malvern Hills, to give the results of an examination of the superposed Palæozoic strata, and to state the chronological relationship of the several events in their geological history.

It was concluded that the rocks hitherto treated of as syenite, and supposed to form the axis of the range of hill, are in reality of metamorphic origin, consisting of gneiss (both micaceous and hornblendic), mica-schist, hornblende-schist, etc., all invaded by veins of granite and trap-rocks. It was then shown that the Holly-bush Sandstone is the equivalent of the Middle Lingula-flags, and that the overlying black shales correspond with the Upper Lingula-beds, the whole being overlaid, as in Wales, by Dictyonema-shales. These rocks, on the east of the Herefordshire Beacon, are altered by trap-dykes, which were shown to be of later date than those traversing the crystalline rocks before alluded to. Allusion was next made to the Upper Llandovery strata, which overlie unconformably the Primordial rocks just noticed; after which the several faults in the district were described in detail.

Dr. Holl concluded with some remarks on the general relations of the rocks of the Malvern Hills with those of the surrounding districts, describing the successive physical changes supposed to have been consequent upon their deposition and their subsequent elevations and depressions.

Specimens of the new mineral termed Langite, a basic sulphate of copper, were exhibited by Professor Maskelyne.

ROYAL SOCIETY.—*June* 9.

Human Remains in the Cavern of Bruniquel.—Professor Owen described his investigations in the cavern at Bruniquel, in which human remains occur, with those of extinct and other animals, both being associated with bone and flint implements. Professor Owen argued that these human and extinct animal remains were contemporaneous, as shown by their relative position in this cavern, and by the similarity in their chemical composition.

The remains found in this cavern were those of numerous individuals, the skulls corresponding more closely to the Celtic type than to any other known form. As, in most primitive races, the digestibility of the food appeared to be but little aided by the process of cooking, as the molars were worn down to the stumps far beyond the enamel, exposing the osteo dentine, which, however, did not show any signs of decay.

Microscopic Soirée at Apothecaries' Hall.—The Master and Wardens of the Apothecaries' Company, gave a very successful and numerously attended scientific entertainment on the 31st of May. All the principal makers of microscopes were well represented on

the occasion, and the collection of objects was very good. The principal novelties were an opthalmoscope, by which the vessels in the interior of a rabbit's eye were distinctly seen; a new aneroid, by Mr. Browning; and a beautiful diffraction apparatus, by Messrs. Horne and Thornthwaite. The two last deserve a much longer notice than we can give them in this place. The aneroid, which we hope to describe fully another time, is a stationary instrument of extreme delicacy, enabling small oscillations to be read off on a large scale, and admirably adapted for noting the exact progress of atmospheric waves during a storm.

Mr. De la Rue's Astronomical Soirée.—On Saturday, June 4, Mr. Warren De la Rue, the President of the Royal Astronomical Society, held a reception at Willis's Rooms, which was attended by a very numerous and distinguished company. The arrangements were made with great liberality and good taste, and a variety of important and interesting objects were brought together. Mr. Nasmyth exhibited some large and wonderful drawings of lunar craters; Earl Rosse sent sketches of nebulæ, and the walls were adorned with some singularly beautiful landscapes of Turner. Steinheil sent a Gauss object-glass upon the pattern mentioned in a former number of this journal, and Merz sent a 10-inch object glass; Cooke and Sons showed some fine telescopes, and a new arrangement for obtaining a dark field illumination; Messrs. Troughton and Sons exhibited instruments for the Indian Survey, among which was an enormous theodolite in aluminium bronze. Mr. Browning's new aneroid attracted great attention, and he also exhibited some splendid prisms, one on a large scale, being constructed of quartz, and made for Mr. Gassiott, who was fortunate in securing a crystal of rare dimensions and unusual freedom from optical defects. Messrs. Horne and Thornthwaite, in addition to their diffraction apparatus, for which Mr. Bridges designed the figures, exhibited a new form of polariscope capable of showing a much wider range of effects than the usual patterns allow to be seen, and in a manner that commanded universal admiration. Mr. De la Rue exhibited a complete collection of his astronomical photographs. Messrs. Powell and Lealand, Ross, and Smith and Beck brought their microscopes, the latter showing the pupa of the flea and the Acarus Crossii. There were also specimens of the long focus telescopes that preceded the achromatics, and numerous instruments of the most modern designs. Mr. Ladd exhibited some fine effects with vacuum tubes.

NOTES AND MEMORANDA.

THE CONSERVATION OF POLLEN.—M. Belhomme details to the French Academy numerous experiments on the "persistence of the fecundating power of pollen." He gathers anthers in dry weather, at the moment when dehiscence begins, seals them up in bottles, and places the bottles in a dark, dry place, in which the temperature will not exceed 6° or 8° C. The pollen grains that have been successfully preserved remain slightly moist, those which have dried so that they do not adhere slightly to the skin, and those which fall like dust, are spoilt. He has proved that the pollen of the lily tribe can preserve its fertility for five or six years, that of the musaceæ he has preserved for six years, of the borage tribe one year, and of the potato tribe two years, of cactuses three years, and of the rose and bean tribes two years.

DEVIATION OF COMETS' TAILS.—M. Valz shows that the tails of Comets iv. and v., 1863, deviated from the planes of their orbits. He adverts to two other comets in which the same fact was ascertained.—*Comptes Rendus*, No. 19, 1864.

USE OF ELECTRICITY IN BRIGHT'S DISEASE.—M. Namias communicates to the French Academy a case in which the obstacle to the separation of urea from the blood was removed by the application of galvanism to the loins of the patient for half an hour. Twelve of Daniell's cells were employed, and the quantity of urine and urea much increased. More albumen was also secreted, but M. Namias states that this was of small consequence compared with the benefit resulting from a greater elimination of urea.

ALVAN CLARK ON THE SUN AND STARS.—Mr. Alvan Clark views the solar image in a dark chamber. The sunlight is admitted through a vertical aperture, received by a prism, and reflected horizontally on to a pleno-convex lens. The solar image thus obtained is viewed from a distance of 230 feet, and its diameter reduced 93,840 times, being then scarcely equal in illuminating power to *a* Lyra (Vega). Making allowance for loss of light through the apparatus employed, Mr. Clark considers that if the sun were removed 103,224 times his actual distance from us, he would not give us more light than the star in question, and this distance, he observes, is not half the presumed distance of the nearest fixed star. He also alleges reasons for supposing that our sun may be a small star in comparison with some of the millions of other stars that inhabit space.

STRUVE ON THE COMPANION OF SIRIUS.—In the *Monthly Notices* will be found a paper by M. Struve detailing his observations on the satellite of Sirius. The average of good observations in 1863 gave 10''·14 as the distance, and 80°·5 as the position; while the average of good observations in 1864 yielded 10''·92 distance 74°·8 position. According to which the annual change of distance is 0''·77, and of position °5·7.—This nearly coincides with Mr. Safford's calculations, based on the supposition that thére is no physical connection between the two stars. M. Struve does not, however, consider this view established, and suspends his judgment till next year.

HABITS OF WASPS.—Professor R. L. Edgworth has a paper in the *Annals of Natural History* on Irish wasps, in which he denies the statement of Reaumur, repeated by Kirby and Spence, that at the first cold of winter, wasps kill their young. He says possibly the grubs, in some rare cases, may have been killed by an early frost, and it may have been thought they were intentionally slain. He states that the wasps are hatched before cold weather usually begins. The love they display for their young, and the place of their birth, he characterizes as very remarkable, and he adds that they soon become familiarized with any animal or man. In one instance he tells us that a field-mouse and a nest of wasps shared a common hole, without injury to the former. The presence of other wasps does not appear to disturb their equanimity, and in one case he planted four colonies together, and they all flourished. He also bisected two nests and put the halves of dissimilar nests together. The wasps surrounded both halves with a common shell, and made one nest of it.

Action of Tobacco on the Pulse.—M. Decaisne states, in *Comptes Rendus*, that in the course of three years he has met with twenty-one cases of intermittent pulse occurring among eighty-eight incorrigible smokers, and independent of an organic disease of the heart. He calls the affection thus induced by the abuse of tobacco, "Narcotism of the heart."

Bolide of May 14.—At Nérac, on this date, a very luminous bolide was seen in the evening, and four or five minutes after its passage a powerful detonation was heard, accompanied by a rumbling like thunder. At St. Clar the light was so brilliant at 8h. 13m. as to give rise to the idea that the village was in flames, and the meteor looked nearly as big as the full moon. It left a train behind it, which gradually disappeared, and in the course of ten minutes a noise was heard like the discharge of a cannon. Letters from Astaffont, Sauzon, and Blois reached M. Le Verrier with analogous particulars. The Curé of la Magdeleine describes the meteor as opening like a bouquet of fireworks. Superstitious folks thought the world was coming to an end. M. Daubrée observes that the interval between the appearance of the meteor and the noise was two minutes at St. Clar (Ger), three to four at Agen, and at Astaffont (Lot et Garonne) four minutes. From these data he concludes that the explosion took place at a great elevation and in a highly rarified atmosphere. M. Brongniart made observations at Fisors (Eure), from which he estimated the meteor's height when the explosion occurred at about 30,000 metres. He states that at the close of the phenomena there was a fall of stones, several of which were picked up. M. Flammarion, writing in *Cosmos*, states that this meteorite contained carbide of iron, and belonged to a rare type. Numerous letters on this subject will be found in *Comptes Rendus*, No. 1, 1864; and also in No. 21, in which M. Laussedat details his efforts to compute the size and trajectory of the meteor. He finds many of the reports irreconcilable, but by combining an observation made at Nèrac with another at Tombebœuf, near Miramont, he considers the bolide must have been near the meridian of Nèrac, and about 100 kilometres high.

The Anacharis in Flower.—It is commonly, though not correctly, said that the Anacharis alsinastrum does not flower in this country. It will, therefore, interest our readers to learn that Mr. Mumbray, of Richmond, has recently obtained specimens in flower from the Hampstead ponds. The flower, which is borne at the end of a thread-like stalk, is an elegant object when viewed with an inch power. The ponds on the Lower Heath contain abundance of specimens. The Anacharis belongs to the Hydrocharis family, in which the flowers are unisexual, and it is the male flowers that have not been seen in England.

Cure of Febrile Cephalalgia.—M. Guyon communicates to the French Academy cases in which the acute head pains in fever have ceased on the application of pressure to the temporal arteries. A steel band, passing half round the head and furnished with little cushions, he finds a convenient mode of making the application.

INDEX.